Decentralized Governance

By Craig Calcaterra and Wulf Kaal

Abstract

Chapter 7 introduces governance designs for decentralized systems. Decentralized governance is the process of keeping decentralized organizations stable and on track to achieve their goals, without letting them devolve into a centralized organization. Decentralized organizations are naturally more difficult to control than centralized organizations. They are more difficult to govern. Very few existing P2P project have anything close to a sophisticated governance process.

The authors show that reputation is the key to achieving effective decentralized governance. Reputation gives the promise of future rewards. Reputation can be objectively valued, by estimating the probability of future business deals, taking the expected value of that probability, and calculating the present value of those business deals. Yet this value can seemingly be created from nothing, in a place it didn't exist before, based solely on whether the participants choose to display good will toward each other. This makes reputation a positive-sum property from the game-theory perspective. A reputational system that is formally linked to profits makes the members forward-thinking and cooperative, to combat the natural tendency of competition to separate members. It also motivates members to self-police their past investments. Reputation changes the incentive structure from a single-stage, zero-sum game to a repeated positive-sum game.

The book can be accessed here:
https://www.amazon.com/Decentralization-Technologies-Organizational-Societal-Structure/dp/3110673924/
and here:
https://www.degruyter.com/view/title/569051

Chapter 7. Governance

“Many people believe that decentralization means loss of control. That's simply not true. You can improve control if you look at control as the control of events and not people. Then, the more people you have controlling events - the more people you have that care about controlling the events, the more people you have proactively working to create favorable events - the more control you have within the organization, by definition.”

—Wilbur L. Creech, The Five Pillars of TQM, 1995.

Governance is a fundamental human concern, which has been continually debated since humans learned to speak. Governance is a primary subject of study within philosophy, ethics, economics, political science, law, sociology, social psychology, cybernetics, control theory, etc. Choices of governance structures for DAOs must consciously grapple with these theories and examples that have arisen throughout history. Throughout history, however, people have repeatedly failed to organize effectively, and corruption has arisen in every circumstance, even without anonymity, in the less extreme situation involving identified members of the same culture under face-to-face circumstances with deep community ties. What chance do we have of eliminating corruption and perfecting our governmental institutions? None, of course. In his Dictionary of Philosophy, Voltaire highlighted the Italian proverb, “Il meglio è l'inimico del bene.” The perfect is the enemy of the good. But we can improve our institutions if we use the advances of technology wisely. Today we have new tools at our disposal for improving governance.

Governance is the set of protocols that determine what behaviors are acceptable or unacceptable and how they are rewarded or punished. Governance determines how an organization is organized. Governance is the organization. Governing a decentralized organization, however, is much more difficult than governing a centralized hierarchical organization.

This book probably seems obsessed with stability. In order to achieve the goals of a decentralized organization, some measure of control is required. The organization must be organized. Decentralized organizations are naturally more difficult to control than centralized organizations. They are more difficult to govern. The word “govern” comes from the Greek kubernos meaning to steer. Kubernos is the origin of the term cybernetics, which is the mathematical subject of control theory, which helps us steer rocket ships to the moon and steer underseas robots through the Mariana Trench. Control theory gives us the design to keep controlled explosions running stably for decades in nuclear reactors, and it keeps our global supply chain running efficiently with less redundancy and downtime thanks to dynamic programming.

Steering a decentralized organization, guiding it without centralized control, is a delicate procedure. Governance is the process of keeping the organization stable and on track to achieve its goals, without letting it devolve into a centralized organization, which is a natural progression once clear goals are identified and competition emerges.

There are flaws with every governance process that has ever been implemented. In fact, it seems clear no perfect governance system is possible under very minimal assumptions, such as non-dictatorship (cf., Chapter 4). Nevertheless, it is our goal is to find practical and effective governance structures for the most challenging groups that exist: DAOs.

Part of the challenge of governance is that most members should never notice its existence—when they do, something has probably gone wrong. The best governance will require only the subtlest changes in the reward mechanism to keep the organization healthy as changes happen in the DAO and in the marketplace. Ideally, even these subtle changes would be automated, so that only changes to the changes need be debated.

Decentralized power has been a conscious goal since the 18th century.1 In the long term, or when the situation is dynamic and unpredictable, decentralized organizations can be more efficient than hierarchical organizations. We gain greater flexibility and more options for efficiency using the decentralized power structure of interacting domains of expertise. Now the technology of accounting has caught up, so that it is possible to account for good and bad behavior on a seemingly infinitesimal scale without resorting to a centralized system for recording, processing and transmitting information. Advances in digital electronic data storage make it possible for the first time in history to record every member's contributions to an organization. P2P technology gives actors and organizations the environment to collaborate on neutral ter-

[1] Of course, there are many precursors which are also worthy of study. Quaker governance, since the 17th century, has put special emphasis on nurturing member communication with strict protocols. No decisions are ever made except unanimously (which may account for their doctrinal fragmentation into various sects). There are no votes. Debates are not permitted, nor even direct responses to others' contributions. The idea is not to have your personal argument win, but to discover God's will.
Ancient Greek society hosted a particularly direct democracy which governed the highest decisions to the lowest, from deciding whether to wage war down to where the next street will be built. Greek direct democracy relied on a clever process of sortition. Sortition is the random selection of representatives. They used a *kleroterion*, which was a device somewhat analogous to a complicated bean board or pachinko machine, to select their temporary delegates.
In a testament to the power of logic to withstand millennia of change, Aristotle's *Ethics* and *Politics* (4th century B.C.) are still remarkably cogent expositions categorizing and analyzing the different possible governance structures, whose insights are required reading for 21st century digital architects.

ritory, where each member has equal power in creating the environment where everyone can broadcast to and receive from an unlimited network of members. We have arrived at a historically novel situation technologically. We now have the power to create far more decentralized and democratic institutions than ever before.

Decentralized organizations can be more productive because they can distribute the proper amount of power to the proper talent at the proper time, eliminating system frictions such as corruption. To ensure such dynamic power organization is successfully implemented, the governance structure of a DAO must incentivize members to collaborate productively, by fairly rewarding development, work, and the policing of any diminishments.

Many issues arise when attempting to implement a governance system which incorporates these qualities yet is also effective and efficient. Benevolent dictators are much more efficient and effective than messy democracies, but the long-term stability of a powerful public P2P network is threatened by such centralized governance. So there is naturally debate (in the blockchain community, e.g.) about the best way to find consensus on protocol changes.

There is not a single P2P project in existence today which has anything close to a sophisticated governance process. Most are grounded with a strong anarchic or libertarian attitude. These revolutionary projects are responses to failings in our current system. Therefore, the very mention of a constitution for a P2P platform has invoked a reaction of disgust in the past. Developers have naturally been suspicious of any attempt to build old systems of control into their revolutionary platforms. The old systems are failing, and new architectures are necessary to properly exploit the technological innovations of this new age.

All P2P networks need to organize soft forks for protocol upgrades, because there can never be a perfectly designed system, as the Folk Theorems attest. More practically, every network has to continually improve to survive. To attract members and users, user interfaces need to be intuitive; the programming interfaces must keep up to date with the latest changes in software design to keep and attract developers; the technology must use the latest engineering advances for hardware. How do you motivate all this work?

Blockchains which have instituted (or intend to institute) on-chain governance to a greater extent include Dash, Bitshares, Lisk, MemoryCoin, Tendermint, Tezos, Aragon, Cardano, Maker, and NuShares. To a lesser degree, the Ethereum carbon vote represents on-chain governance. Examples of off-chain democratized blockchain governance has included Bitcoin Improvement Proposals (BIPs), Ethereum Improvement Proposals (EIPs), mailing lists, and nonbinding suggestion pages on the internet such as GitHub trees. At the moment, however, no major blockchain is entirely decentralized, because they all lack pure binding coded P2P anonymous governance.

Choosing no explicit or formal rules is still a governance choice. That choice defaults to the prehistoric rule of might makes right. Since might is defined by wealth, they've chosen oligarchy. In 2020, all of the major valuable platforms are naked oligarchies, where rule changes are determined by whoever has the most fungible platform currency or concentrated computing power.

The entire history of civilization has shown us how dangerous that is. It leaves itself open to many arbitrage opportunities, such as Soros' Break-the-Bank attack on the British pound. (We'll discuss that example in Chapter 8 for stablecoins.) This is especially insecure in a system that strives for anonymity and places itself beyond the protection of any national jurisdiction. Currently, there are not many useful institutions such as banking in the decentralized economy which would allow adversaries to take advantage of their governance weaknesses. With only a few 100 billion USD in capitalization driven entirely by speculation that it may be useful in the future, the crypto economy is not yet a significant factor in international commerce. Competing platforms have an incentive to keep the peace until these P2P platforms prove the economy needs them. However, we can witness these realities developing quickly. When they do materialize, the decentralized economy will be rocked by catastrophes which expose these weaknesses.

The lack of governance is especially dangerous for these P2P platforms, because it is extremely difficult for decentralized organizations to change their rules. The United States built a system into its Constitution for amending the rules, but in 230 tumultuous years of operation there have only been 14 changes. This despite yearly crises, including a civil war that split the country across the middle. This despite changes in information technology that started with writing the original rules with goose feathers on sheepskin. Hundreds of millions of new network members follow those old rules, but now the rules are shared by bouncing them off satellites in space between citizens' pockets.

When a large decentralized organization needs a fundamental rule change, it often happens because a large minority subgroup is being treated unfairly. That typically means the majority is advantaged by the rules and are therefore not incentivized to change the rules. Then the only way to make foundational changes is revolution. When Ethereum chose to make a minor change to fix a single bug exploited by a single member (the 2016 DAO attack) a minority revolted, splitting the network. Distributing power in a valuable network creates major path dependencies. Getting the governance system right from the beginning is absolutely crucial.[2]

[2] "You will never get right until you start right." –Voltairine de Cleyre, *The Economic Tendency of Freethought,* Liberty, Vol. XI, #25 (1890).

Currently, the vast majority of Web3 projects rely on their founders to do a good job at the beginning and hope there never needs to be an important structural update after the first roadmap is complete. Since the field is in massive flux, the lack of governance is pretty well hidden. No important roadmaps have been completed, yet. The fact that the reliance on founders represents de facto centralization isn't too glaring, yet. At the moment, since new companies come and go, new problems can be addressed by cloning older open-source architectures with superficial changes.

Since no major P2P organization has anything resembling effective decentralized governance, none of them are viable in the long term. They will all eventually be disrupted with superior clones. This doesn't mean they won't be useful in the short term, so predicting when they will become irrelevant is impossible.

It is perhaps understandable that these immature systems don't have sophisticated governance mechanisms. Designing a single consensus algorithm is infinitely easier than designing a consensus algorithm that will incorporate all future updates to the consensus algorithm. Before the decentralized economy can actually emerge to improve our current institutions, though, this must be achieved for long-term stability. Many developers are beginning to understand this, and the hard line against constitutions is softening.

How do we achieve governance in a decentralized organization without imposing a centralized hierarchy to make decisions? Fortunately, we've been addressing this impossible necessity and developing governments based on decentralized principles throughout history. Egypt practiced decentralized judicial governance for 3000 years. Every democratic government since Ancient Greece has been an experiment in decentralized executive governance. The most powerful DAO in history was the United States. All governments have been flawed, but we can learn from their mistakes.

In this chapter we explore what is needed to design an effective governance process for a decentralized network or DAO without any central hierarchy to make decisions or drive innovation. Essentially, we need a constitution for a radically democratic organization. An incorruptible governance process, one which has never been achieved before, sounds unlikely—especially as we witness old and established democratic institutions failing.

But there are new information technology tools that give us more power to democratically govern decentralized organizations. We can poll every member of the group almost instantly. We can keep track of every member's contributions. We can judge them according to programmed processing of unlimited complexity. All of these information technology tasks can now also be achieved redundantly, by each member of the group, so each member is autonomous and doesn't rely on some central overseer or repository.

The only requirement for decentralized governance is to design this third governance processing protocol by which the entire organization can agree to judge each other by. The first goal of this chapter is to identify such a governance process that keeps the organization decentralized and stable.

Secondly, once this governance process is established, we need to make design choices that reflect the goals of the group. The goals are literally what the group values. For instance, if the group values long-term stability, they should encourage investment and tokens of power which pay annuities in the long term. If they value immediate innovation, they should reward development more than maintenance.

Decentralized governance with new IT tools

The purpose of a pure DAO is to allow any users on the planet to join anonymously (or pseudonymously). Such users have a natural incentive to exploit any opportunity to profit personally, even if it comes at the expense of the group. At the same time, DAOs have no centralized authority empowered to police or guide behavior. A program for solving all these problems under these extreme circumstances is forbiddingly ambitious. What hope do we have of finding an effective governance structure when users are likely to be pseudonymous and occupy uncertain locations in various jurisdictions?

How do we create a system which can update itself in a peaceful, stable, and predictable way, in response to unpredictable future changes in the market? We need a constitution which outlines the powers of the legislative, executive, and judicial systems of the decentralized network. The legislative system updates the constitution itself. The executive system enforces the constitution. The judicial system handles inevitable disputes. All of this needs to be built into a code-is-law smart contract small enough to be easily parsed and audited by humans and run efficiently in a redundant peer-to-peer setting.

Contemporary P2P technology allows us, for the first time in history, to coordinate communication without a centralized authority in a secure and redundant fashion, to keep track of every important contribution, and to store those records eternally for future review. This review gives us the chance to analyze the consequences of every action and fairly reward the positive contributions to the group and punish the negative. One of the major efficiencies of a decentralized organization is that all rewards can be shared with the people who contribute to the success of the group, fairly, according to their merit.

We broadly define corruption in an organization as any action that benefits a minority at the greater expense of the group. Corruption arises when power is distributed inappropriately as measured by efficiency. Corruption arises in the dark, when

people or institutions have the power to act without review. Broadcasting technology provides us the opportunity to transparently share evidence of all actions so they can be reviewed. Processing technology gives each person the power to independently judge these actions' value. This inhibits corruption, by distributing power efficiently to those who can use it best to improve the group.

Just because we can cite every action from a company on a blockchain, however, does not mean we have conquered corruption. More information does not ensure more productive collaboration. How do we discern the signal through the noise? Members must be properly motivated to behave correctly and to police corrupt behavior when it happens. This is the goal of governance.

Cash profits are a bad immediate incentive for business and government. The cartoon scenario of a DAO consisting of anonymous members who stake their currency on rigid smart contracts gives the worst imaginable motivations for collaboration. If the entire proximal goal of a transaction is currency, all participants will naturally behave in the most selfish manner possible, exploiting any opportunity for individual profit at the expense of the group.

Further, rigid "code is law" smart contracts involving fungible currency exchanges are designed to guarantee irreversible, unreviewable, programmed self-execution. Very rarely does any business venture proceed exactly as imagined from the beginning. To enter into any business arrangement, parties need to have confidence that fair resolution will occur when transactions do not go according to plan. They need to know whether to continue business after an unforeseen event.

Moreover, rigid "code is law" smart contracts will need to be extremely complex to account for the many possible eventualities of practical business situations. The insurmountable reality is that bugs or hacks can never be certainly precluded in any programmable contract.3 Beyond this, long-term attacks will always be possible for any complicated and rigid set of rules, as the infinitude of strategies generated by the Folk Theorems demonstrates. If the entire reward is short-term currency profit, all parties are naturally motivated to push the contract as far as possible in their favor, and they will naturally exploit any weakness in the contract design to their advantage.

The typical engineering attitude is that such problems can be entirely avoided with perfect system design. This is naïve. Exceptions will always exist. Business competition always seeks optimal solutions which occur at the limits of the rules of behavior. Good system design is possible, but requires dealing with the exceptions. Once the process is in place for dealing with exceptions and improving the process to handle exceptions, exceptions become more and more rare, and the system becomes more efficient. As much as possible, we must automate such constitutional functions for

⍰⍰
[3] Despite the laudable efforts toward secure purely functional programming languages such as Haskell.

efficiency. This requires explicit formal rules for as many behaviors as possible, which multiplies the protocols without limit. In tension with this requirement, we must limit the rules to make them as simple as possible and allow maximum freedom for innovation. The ideal rules never need to be enforced as they are naturally incentivized by productive cooperation that achieves the goals of the group.

The motivation for all parties to behave as selfishly as possible creates instability for any business transaction. More harmonious collaboration is motivated when improved reputation is the proximal goal. The situation is no longer a zero-sum game when either or both parties can create valuable long-term reputation from the transaction.

Instability from profit motive and rigid rules

The major characteristics of the network that dictate design choices are 1) whether the group is devoted primarily to profit, and 2) the values of the group.

The two ends of the spectrum are non-profit organizations with uniform values, and for-profit companies with diverse values. Ideologically centralized (uniform values) nonprofit organizations are extremely stable and work well without explicit rigorous rules. Historical examples include much of the history of Imperial China, the Apache's nomadic period, and Wikipedia. DAO examples would include nonprofits devoted to charity, local community social organizations (like YMCAs), and local governance sub-councils devoted to improving the community of a non-diverse population. The less explicit the rules are, the more they should not strictly adhere to precedent—spirit of the law must supersede the letter of the law. If the system has less explicit rules, the unifying force is transcendental values—values which cannot be explicitly written down, dictating what is acceptable or not. An example of a transcendental value is the Golden Rule, "Treat others like you would be treated." An example of an explicit rule is, "Murder is punished with 10 years in jail."

Ideologically decentralized (diverse values) for profit organizations are the decentralized organizations we are concerned with in this book. They are on the other end of the spectrum from value centralized non-profit organizations, and so they are naturally very unstable. We assume these DAOs want to maximize the network effect, and so are trying to build the largest, most inclusive group of members possible. They are open to anonymous members with a diverse set of values from a globally diverse set of cultural backgrounds, who can join or leave at will. These characteristics make such DAOs extremely unstable, so they need powerful stabilizing structures.

The internal competition for profit creates the natural tendency to centralize power as the members differentiate themselves with wins and losses. This centralizing tendency is another force further destabilizing the organizations.

Diverse (decentralized) values require protocol centralization (explicit, enforceable rules), because stability requires impartial application of laws to display fairness. Explicit rules can unite a larger group of more diverse members. In other words, the governance system must follow rigid Rule of Law, instead of loose Rule of Virtue.

Explicit rigid rules are also more efficient. Members waste less energy making choices.

However, these unifying rules further destabilize the group in the long-term, because of internal corruption and external changes that make the rule structure ineffective or inefficient.

This situation of for-profit, open, diverse-valued, rigid Rule of Law run decentralized organizations is maximally unstable. Therefore, you must add powerful stabilizing forces to their governance.

Reputation counters instability from profit motive

The main problem with all current P2P governance structures (such as they are) is the lack of proper incentivization. In business or in government, all participants need to be motivated to improve the whole organization over the long term. Otherwise, when short-term fungible rewards are available, the natural response is to always attempt to game the system for maximal personal profit and to ignore how your actions may damage the group.

A reputational system that is formally linked to profits makes the members forward-thinking and cooperative, to combat the natural tendency of competition to separate members. It also motivates members to self-police their past investments. Reputation changes the incentive structure from a single-stage, zero-sum game to a repeated positive-sum game.

Reputation gives the promise of future rewards. Reputation can be objectively valued, by estimating the probability of future business deals, taking the expected value of that probability, and calculating the present value of those business deals. Yet this value can seemingly be created from nothing, in a place it didn't exist before, based solely on whether the participants choose to display good will toward each other. This makes reputation a positive-sum property from the game-theory perspective.4

⍰⍰

[4] Arguably the source of good will would be the promise of profit from rational choices in long-term cooperation in an expanding market. Like physics experiments where energy is added to a subsystem, Conservation of Energy is not actually violated from the wider, universal perspective. The positive-sum situation holds from the near-sighted perspective of specific subgroups over a limited time period.

No centralized platform, such as Amazon or eBay, has been able to create meaningful and secure online reputation. Because they are centrally owned and controlled they cannot give members the power and incentives they need to police their own reputation, protecting it from the infinite strategies available to adversaries for subverting the intentions of the designers (which the Folk Theorems of Game Theory illustrate). With the new opportunities that P2P technology creates, decentralizing and distributing reputation fairly, and tying it to the profits of the organization, the members can be properly incentivized and empowered to police all actions. Giving DAO members the ability to fairly apportion power in a variety of domains lessens the danger of the principal-agent problem and combats several Tragedy of the Commons problems, such as non-representativeness and free-riding.

A platform which vests users with secure and valuable reputation gives us the opportunity to effectively filter the voluminous information that contemporary technology produces. People with higher reputation will have greater voice.

Power is diffused by reputation, as discussed in Chapter 6. Thus, reputation stabilizes the organization by decentralizing it. One of the major sources of instability from unequal power distribution is the ever-present possibility of a majority oppressing a minority. De Tocqueville criticized American democracy as being particularly susceptible to this Tyranny of the Majority and argued it could ruin any democratic organization. De Tocqueville and Madison5 and others claimed the best safeguard against this is by diversifying interests. Giving individuals more autonomy naturally

From the eternal perspective, reputation allows the system to achieve a sub-game perfect Nash equilibrium with a higher profit level, so the reputation is not value created from nowhere.

[5] "It is of great importance in a republic, not only to guard the society against the oppression of its rulers, but to guard one part of the society against the injustice of the other part. Different interests necessarily exist in different classes of citizens. If a majority be united by a common interest, the rights of the minority will be insecure. There are but two methods of providing against this evil: the one by creating a will in the community independent of the majority, that is, of the society itself; the other, by comprehending in the society so many separate descriptions of citizens as will render an unjust combination of a majority of the whole very improbable, if not impracticable." –Federalist No. 51 (6 February 1788)

"In a free Government, the security for civil rights must be the same as that for religious rights. It consists in the one case in the multiplicity of interests, and in the other in the multiplicity of sects. The degree of security in both cases, will depend on the number of interests and sects; and this may be presumed to depend on the extent of country and number of People comprehended under the same Government." –Federalist No. 51 (6 February 1788)

"The essence of Government is power; and power, lodged as it must be in human hands, will ever be liable to abuse." –Speech in the Virginia Constitutional Convention, 2 December 1829, The Writings of James Madison: 1819-1836 (1910), ed. Galliard Hunt, p. 361

diversifies the expressed interests of a group. Encouraging individual autonomy by decentralizing power creates more minorities, which is the best way to protect minorities.

Any such reputation system must address the many problems, such as sockpuppet attacks, Tyranny of the Majority, Tragedy of the Commons, 51% attacks, and free riding, that have undermined the meaning and value of digital reputation on all previous platforms, centralized or decentralized. Further, it needs to be a dynamic and evolutionary system, able to anticipate and react to gaming that will inevitably result from whatever rules are in place. Review Chapter 6, to see how to address such problems.

Alternatives to reputational systems for countering the instability generated by profit competition include external stabilizing forces (such as governmental fiat) or rapidly expanding profit opportunities (which will only stabilize a group until the expansion stops). Colonialism gives historical examples, such as the Spanish Empire in the Americas or the Dutch East India Company.

Trying to institute dynamic rules to attenuate the instability due to a for-profit motive is a mismatch. Similarly instituting a reputational system is not an efficient method for attenuating the instability due to a group's diverse values.

Once reviewable reputation is the focus instead of more fungible currency rewards, damaging arbitrage opportunities are minimized. The next major concern for creating a healthy governance process is to decide how to reach consensus on protocols for behavior. What process do we use to enforce laws?

Dynamic design counters instability from rigid rules

The instability generated by the rigidity of the rules is solved by making the rules dynamic. Dynamic governance includes short-term and long-term protocols. An appeals process stabilizes short-term cooperation (day to day business, single contract). Long-term stabilization (year to year, group to group, part of one generation) comes from legislation, the ability to amend rules—including how the amendments themselves are made. For even longer-term stabilization (generation to generation), adherence to transcendental values guides higher-order rulemaking.

Like the dynamic design of the U.S. Constitution discussed at the end of Chapter 1, which stabilized and decentralized the federal hierarchy, we can add dynamic design to DAO governance to encourage decentralization (or equity or meritocracy or any other value your organization holds). Larger changes are effectuated by legislative governance. Subtle changes in reward parameters can be automated to steer the DAO toward the goals of the group.

Executive short-term governance automated with hard protocols

Short-term cooperation is regulated by executive governance. This is single-contract policing. Executive governance is regulatory governance—policing. Such regulation should be governed by hard protocols. In other words, in a decentralized organization, the entire executive branch's function is automated.

Hard protocols are programmed rules for how the organization performs its functions. For instance, each DAO will automatically share profits with its members, where the core program will automatically calculate each member's salary in proportion to their reputation token holdings relative to the entire group. As a second hard protocol example, each DAO will determine how reputation creation, distribution, and policing are handled—for instance the level of approval required before reputation tokens are granted. As a third example, references to past work-evidence posts will re-valuate member reputation. Precisely how does a reference reward the author? The many possible options provide many diverse choices of incentives with which to motivate DAO members, as will be examined throughout the book. Such hard protocols determine the programmed reward/punishment structure of each DAO.

In a radically democratic system where power is truly decentralized, each member of the organization is in charge of all executive governance, all the time. With the new tools of information technology, this is now possible.

As described above in the system which generates reputation, each member is capable of participating in the validation pools. In this way, when the system is working properly, the executive system is completely automated. Every validation pool on executive governance should be completely uncontentious, with every vote resolving unanimously. The only time a member should use their executive power consciously is when they decide whether to join, i.e., whether they want to run the program which polices the members or not. After that choice, the hard protocols are entirely algorithmic, in the sense that anyone honestly following them will automatically choose the correct vote, which drives the system to unanimous consensus. The most efficient applications should be automated, so that honesty is defined as running the algorithm the organization has agreed upon, unedited.

The only time the members should make a conscious choice when using their reputation tokens for governance, is if they are interested in participating in the legislative governance process of debating updates to the hard protocols.

Policing is an overhead institution in our traditional economy that centralized personal defense. Policing as we know it, with permanent, professional, centralized police bureaucracies funded by taxes, is only about 200 years old. Throughout history there

were decentralized militias and posses, that were based on communal spirit in democracies or family-oriented clans (e.g., Imperial China and feudal Italy6). Governments always employed specialized military units for policing their citizens, but before the modern era, there were rarely any standing armies, so policing was intermittent. Aside from this, marshals and constables were typically paid by courts or individuals with bounties or retainers.

Starting in 1800 in London, public taxes first funded the Thames River Police to prevent crime near merchant import properties, following a royal French system that predated it. Motivated by this success, the 1829 Metropolitan Police Act created the first modern police force, that is, the first public police bureaucracy for maintaining social order by investigating general crimes. London passed the act to address the social upheaval engendered by the industrial revolution. The U.S. later copied this British innovation in Boston in 1838 and New York City in 1845. The point we are stressing, is that the systems we take for granted as natural are by no means universal nor eternal. Policing in major cities was not well established until the 1880s, and towns with less than 100,000 residents didn't institute salaried police until well into the 20th century.

From a wider, nationwide perspective, outsourcing personal revenge to a publicly-sanctioned, centralized police force led to a leap in efficiency. But this centralized institution is an obvious vector for corruption. Police exist to fight corruption. They understand corruption better than others and are the only group sanctioned to directly address it, so they generally police themselves. Because the centralized bureaucracy is hierarchical, there is less transparency than there would be in a decentralized organization, since only a few people observe what each other person is doing, because of the limited and static power relations within the org chart.

With the advances of information technology, we can achieve another leap in efficiency and security, by decentralizing and automating policing, giving every member of a network the power to check every other member on specific behaviors. Bitcoin does this, e.g., by using error correcting codes and public key cryptography. Whenever a message is sent in the Bitcoin network, each node in the peer to peer network checks the message to see that it is properly formatted following Bitcoin protocol before passing it along in the gossip network. Then each block is hashed many times, and the nonce is checked to police the claim that the hash lottery winner is the correct block producer. Finally, each Bitcoin money transfer is cryptographically checked by every node in the network to verify the transaction sender and recipient accounts are the correct owners of the private key through digital signature technology.

⍰⍰

[6] The Towers of Bologna (https://en.wikipedia.org/wiki/Towers_of_Bologna) are a testament to the function of clan policing. Each clan had a tower from which they could monitor the town.

Advances in information technology, especially processing and transmission of data, enables the decentralization of policing of many other DAO functions, giving each individual in the network the power to check everyone else is following protocol, through the weighted democratic system of validation pools. We will discuss how these can be automated in Chapter 8, when we discuss banking.

Legislative long-term governance with deliberative soft protocols

In order to adapt to changing market threats and opportunities, DAOs need legislative governance to update their hard protocols. How can we develop new rules or protocols in a completely decentralized system with anonymous members? We need to use reputation tokens if we want to achieve complete decentralization, anonymity, and autonomy. Protocol development is contentious, however. If unanimous consensus is strongly incentivized by every validation pool, our DAOs will degenerate quickly, as alternative options will not be raised by members with minority opinions for fear they will lose all reputation tokens. So the basic functioning of validation pools described above is inadequate. One more tweak is needed—loosely coupled votes.

The legislative system in a DAO is the process for updating the system—essentially rolling out new versions of the software all members of the P2P network use. This legislative process can be broken down into the steps of identifying problems, proposing solutions, deciding between solutions, and deciding how to implement those solutions. The goal is to ensure a stable but active legislative process that responds to inevitable market changes. The goal is to drive group consensus toward improvements in the system.

The design should use the reputation system to democratically come to consensus on each of these steps. There are two basic processes: filtering attention to ideas and then debating the ideas.

First the network needs to harness the power from decentralized networks to access information at the edge by filtering their attention to focus on good ideas. New advances in information technology allow anyone in the network to propose an idea and to use an upvote type system, like Reddit or Stack Exchange (but with secure and meaningful reputation), to make good ideas more visible to the group.

Once an idea meets a certain threshold of attention, how do we decide on whether to implement the idea? How do we guarantee consensus on the protocol change? This second process is a series of votes before the larger group. This will involve contentious debates on how to develop new regulatory/executive protocols. Such debates can be held in P2P distributed hash table forums and subjected to a validation pool with loosely-coupled votes. “Loosely-coupled” means reputation tokens cannot be lost during such validation pools, but can still be staked on contentious

posts to register each owner's opinion. Loosely coupled validation pools poll the opinion of the group. These polls allow a DAO to gauge member body opinion without upsetting the balance of power with disruptive token transfers. Such debates encourage authentic deliberation on protocol development, in order to 1) efficiently explore the most effective modes of behavior for the organization, and 2) ensure authentic and thorough consensus on all protocols.

In order to encourage development actually happening, i.e., to force consensus in a timely manner, the debate can gradually move to tightly-coupled votes, where part or all of the reputation tokens staked on a losing bet will be redistributed to the winners. When a protocol development debate finally moves to a perfectly tightly-coupled vote (where all reputation tokens staked on a minority position in a validation pool are lost), proof is given that the outcome has become precedence, the protocol becomes non-contentious, and unanimity is ensured. Updates to the consensus algorithm can be made and it will be ensured that everyone in the DAO will download the new algorithm and run it, or else risk losing reputation tokens when the new protocol is engaged.

Loosely-coupled voting encourages dissenting opinions. Tightly-coupled voting guarantees consensus. The process moving from one to the other can be slow or fast depending on the importance of the debate versus the need to solve the problem rapidly.

In order to enforce a limit on the time of a debate, the DAO may choose to include a mechanism where validation pools transition gradually from loosely-coupled voting to tightly-coupled voting. This transition allows authentic deliberation to take place during the loosely-coupled voting phase, since divergent views are not punished. When the debate transitions to the tightly-coupled voting phase, the Tragedy of the Commons problems of meaningless votes (the "nothing-at-stake problem") and non-participation (i.e., free-riding) are avoided, fairly and stably, because members who do not participate effectively will lose reputation or at least lose opportunities to gain reputation tokens, whose future value will greatly increase if the protocol improvement successfully attracts fees to the platform.

	Binding	Non-binding
Rigid	Non-contentious post & tightly-coupled (E.g., work-evidence post, mandatory plebiscite)	Non-contentious post & loosely-coupled (E.g., poll of consensus on established precedent)
Flexible	Contentious post & tightly-coupled (E.g., forcing consensus on protocol development)	Contentious post & loosely-coupled (E.g., protocol development poll, advisory referendum)

The above table7 categorizes the difference between contentious and non-contentious posts. Non-contentious posts, such as work-evidence posts, will be rigidly policed and binding in the allocation of tokens. Protocols will start as flexible and non-binding when they are validated as contentious posts. Flexible means members will not be required to follow initial contentious post protocols subjected to loosely-coupled votes. Non-binding means no reputation tokens are sacrificed for violating the content of such posts. As consensus is gradually achieved and protocol suggestions become validated in tightly coupled validation pools, the protocols become rigid and binding, so that violating them results in loss of reputation tokens.

This process of moving protocol development posts from contentious to non-contentious is meant to address wicked problems,8 which are generally intractable yet

▯▯

[7] adapted from the EU governance study by Oliver Treib, Holger Bähr, Gerda Falkner, Andreas Follesdal, & Simon Hix, "Modes of Governance: A Note Towards Conceptual Clarification", No. N-05-02. Available online https://www.ihs.ac.at/publications/lib/ep6.pdf (retrieved 6/23/20).

[8] Jeffrey Conklin's defining characteristics of a wicked problem are:

1. The problem is not understood until after the formulation of a solution.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not right or wrong.
4. Every wicked problem is essentially novel and unique.
5. Every solution to a wicked problem is a 'one shot operation.'
6. Wicked problems have no given alternative solutions.

consensus must still be reached in a timely fashion. Therefore, a well-designed method for encouraging careful deliberation is crucial. Approaches from operations research (e.g., problem structuring methods9) to social and political science and history (e.g., Quaker governance, managing a commons10) will help organize the process, depending on the particular application and DAO.

The means by which members come to consensus on protocol development is by following soft protocols. The soft protocols form a socially developed system of rules that guide members in their conscious decisions—as opposed to hard protocols which are automatically, algorithmically followed by DAO members to police the value of work-evidence posts. Such soft protocols are intended to guide members to complete their deliberations following the commonly agreed upon transcendental values of the DAO. A healthy DAO will have an effective set of soft protocols for expressing their common values with regular innovative rule improvements that keep the DAO on an efficient path toward achieving their goals.

These soft protocols move the DAO from loosely to tightly-coupled votes, from legislative governance to executive governance with hard protocols.

The collection of currently validated hard and soft protocols comprise the legal constitution of a DAO. Similar to nation-states, most members of a DAO will never exhaustively analyze every legal facet of the constitution. So, the UI design is as important as the constitution to the success of a DAO.

Minority interests are passively protected by decentralizing power as discussed in Chapter 6. To further protect minority interests and ensure stability, DAOs often will choose to institute certain initial charter rules which are hard coded to require near unanimous consensus to change, similar to a nation-state's foundational constitution. By protecting minorities from the inevitable transient interests of the majority, this would encourage recruitment of a diverse population of members, increasing the DAO's power from the network effect.

⍰⍰
Cf., also, a super wicked problem, which is also relevant. Jeffrey Conklin, Dialogue Mapping : Building Shared Understanding of Wicked Problems, Wiley Publishing, (2006)

[9] Jonathan Rosenhead, "Problem structuring methods" in Encyclopedia of Operations Research and Management Science, 3rd ed., Springer Verlag, pp 1162–1172, (2013)

[10] Ostrom, Elinor, *Governing the Commons*, Cambridge University Press, (1990)

Judicial short-term governance with hard and soft protocols

The necessity for appeals is crucial in any business deal. Business contracts are designed to bring confidence and clarity to the future. While code-is-law smart contracts give a technological leap in efficiency and clarity, with efficient digital self-execution, their supposed self-regulation will always be ultimately lacking.

The smallest problem is programming bugs. These will always be inevitable, even with logical advances such as strong, statically typed, purely functional programming languages such as Haskell, which prevent many of the accidental logical loopholes of more popular languages. Such problems can be solved with an evolutionary platform which has a history and good incentive design to encourage continual improvement in the smart contracts. But business arrangements are becoming more complex. Each successful modification leads to more opportunities for modifications. With each increase in complexity, the "attack surface" of the business arrangement grows. Mistakes will always surface.

Far more importantly, a business contract is a plan for the future. Even if all of the business parties are well-intentioned, plans fail. When you buy wood to build a shed, a few pieces from the delivery may be too twisted or knotty to your liking. Do you terminate the smart contract? Do we build more complex clauses into the contract handling any eventuality? Perhaps we stipulate how many knots the wood can have and measure precisely how twisted the wood is allowed to be. How do we build a smart contract that can judge whether the seller or the buyer is pushing the boundaries?

It doesn't matter whether the other party is well-intentioned or not. Sometimes (often) business parties genuinely disagree. For efficiency, disputed contracts need to be able to be resolved in more sophisticated ways than simply terminating them early. An impartial third party might be able to resolve the dispute in a more efficient manner. The existence of an efficient and fair appeals process helps give parties the confidence to enter into a contract in the first place. A fair and efficient judicial system, like insurance, is a catalyst for business that makes the wider economy more liquid and ultimately, more efficient.

To maintain the efficiency of the self-executing code-is-law smart contract, the appeals process must be built into the code. In the same way the executive functions of the DAO are automated with smart-contract-enabled hard protocols, the appeals process is also automated with hard protocols. Triggers are built into smart contracts that either party is capable of engaging when a dispute arises. The idea is that the assets encumbered in the smart contract from the beginning (digital properties including currencies, tokenized assets, and reputation tokens) would be frozen and partial powers of disbursement would be transferred to a third-party arbiter. This judge would stake their reputation for expert knowledge in the DAO's protocols and experi-

ence with resolving the most common disputes. Then a pre-determined appeals process is enacted. The costs of such a process needs to be transparent and negotiated by the DAO which hosts the smart contract before it is recommended to its customers. A long history of successful and efficient dispute resolution is necessary before customers would gain the faith needed to guarantee the system is worth using from the beginning.

However, soft protocols are also necessary. Beyond the limits of the typical transaction, there will be new events that the DAO must be able to handle. Ideally, these situations would be vanishingly rare, but even then, it is necessary for the DAO to have a system in place to give users confidence. The third-party arbiter must sometimes make a creative decision based on the unique evidence of a novel dispute. In that case, the arbiter should rely on soft protocols that cleave to the spirit of the law, similar to how new protocols are created during legislative debate. These soft protocols would be founded on precedent and guidelines developed over time to steer the DAO toward its transcendental values. Without such unifying ideals, liminal cases will fragment the network. Ultimately, transcendental values are always necessary to maintain the stability of a network, so they are the first thing the DAO should establish.

Network forks and black swans

Finally, there is no way to design a system that can anticipate every future eventuality. Conditions change. The group can develop persistent irreconcilable differences in talents or philosophy or goals. Sometimes the group will be more efficient if competing minorities have the freedom to pursue their own values.

A mechanism for forking needs to be implemented so the value created by the previous history is not erased. Otherwise the group will arbitrarily downvote the minority, creating resentment and unnecessary strife. However, forking should always be discouraged, until the split becomes obvious and detrimental, because of the value lost in any fork due to the network effect.

The mechanism of forking is illustrated by the Ethereum Classic blockchain fork. Members who disagree with a new protocol or vote which results in unfair loss of reputation tokens, can create a new protocol and start their network consensus algorithm from any point in the past, ignoring any new messages sent according to the old protocol.

Eight qualities of effective decentralized governance and authentic deliberation

Seven general qualities have been identified in modern democratic institutions as useful for evaluating how effective a governance system is. Upholding the ideals of decentralization, security, and anonymity while remaining stable in the long run is difficult, and requires the governance structure of the DAO to encourage a deliberative democracy. A deliberative democracy by definition values authentic deliberation for

legitimating consensus on the rules, over the mere act of achieving a majority vote. The eternally reviewable history of any debate in the forum may provide an ideal mechanism for achieving the transparency required for authentic consensus, if the deliberation process satisfies the following eight qualities: 1) open, 2) balanced, 3) conscientious, 4) dynamic, 5) informed, 6) binding, 7) reviewable, and 8) escapable.

Open. An ideal governance process should allow access and power to anyone with the ability and desire to make positive contributions.

Balanced. Power and profit must be shared fairly. Productive contributions must be properly rewarded based on the improvement they make to the group. Negative contributions must be properly punished based on the damage they do to the group. Arguments should be considered from contrary perspectives. Every member has the opportunity to post any contentious opinion without fear of reprisals, especially if they are given the opportunity for anonymity.

Conscientious. Participants should sincerely consider the merits of arguments and act in the interest of improving the DAO. This cannot be ensured without proper security and incentivization.

Dynamic. The governance process must be very flexible if it is to adapt to the inevitable gaming that will occur in any complex group. In this sense, the ideal is to create an evolutionary system where rules are able to continually change to avoid threats and seize opportunities (micro soft forks). The opportunity to review past actions and revalue their worth is necessary. Participants must accept that policies and protocols will eventually change, and so should have a perspective that is open to influence.

Informed. Authentic deliberation is required for the development of the protocols that will guide the behavior of group members toward productive collaboration. Three properties are necessary to authentic deliberation: i) as much information as possible on any subject must be available to all participants, ii) contrary points of view must be considered, iii) the weight of an opinion should be partially measured by expertise.

Binding. If a rule is broken through incompetence or maliciousness, punishment through loss of reputation tokens is necessary. Unanimous agreement is therefore the goal of validation pools for work-evidence posts. In contrast with the desire for the ability to review past actions, clarity on the finality of decisions is required for stability. Arguments have the goal of ending in policy.

Reviewable. Governance is a human institution and therefore flawed. The inevitability of mistakes demands a system to redress them. Injustice undermines stability.

Escapable. Network effects show that forking is often damaging to the total value of any collaboration. So forking should naturally be discouraged. However, persistent, valid, minority opinions will arise in any collaboration between members with different talents. In this case a fork can increase the total value of the individual groups when they are given the freedom to pursue their separate goals yet still receive the recognition they deserve from past achievements. For the health of the system there

needs to be a mechanism whereby a carefully considered fork may be stably effectuated. Ideally a symmetric mechanism would be available allowing branches to merge, perhaps when the larger DAO agrees to recognize the smaller group's reputation.

Secondly, individual members should have a stable way to exit the system by selling their reputation tokens for a fair market valuation of the future expected value of their reputational salary. This is more problematic for reputation than for most other cryptocurrency tokens, since reputation is less fungible because a token's value is tied to the post in which the reputation was created and subject to separate review. But in principle it could be algorithmically valuated.

In a competitive environment, a governance process for 1) an open and 8) escapable system must be 3) conscientious, 5) informed, and 6) binding in order to promote the system's legitimacy. Legitimacy is achieved when members have confidence the governance process is 6) binding and that the process will persist. Legitimacy is at odds with a 4) dynamic structure, since members recognize the process will inevitably change. In the presence of this tension, stability requires the system to be 2) balanced.

The bulk of this chapter is concerned with analyzing how to best ensure the governance process is 2) balanced and 5) informed. The most challenging aspect of good governance in this context is creating a process that properly rewards participants for their contributions, and encourages authentic and thorough deliberation on protocols.

The value of deliberation is at odds with time-efficiency and finality. That is, a 4) dynamic, 7) reviewable, 2) balanced, and 5) informed process is at odds with a timely and 6) binding process. The values and needs of any particular DAO will change between these two extremes throughout its lifetime. The parameters which determine which extreme is preferred include the length of validation pool timeout, the percentage of reputation tokens risked when moving from loosely to tightly-coupled validation pools, and the reference weight standards.

Design choices match values

By subtly manipulating the reward structure in a DAO, it changes the incentives in the group, which drives different values. So, if you want to encourage a particular value, you need to design the governance structure with this in mind. The parameters determining how power is distributed in the DAO determine the reward structure. The parameters determine how reputation tokens are created and distributed (in validation pools) and how their values are reviewed (references and appeals). In this section, we analyze how manipulating these parameters affects DAO security, stability, protocol development, recruitment of members and outside business, and retention.

The goal of good governance design is to engineer the proper incentives so that independent and self-interested actors will discover that their optimal strategy is to collaborate productively toward the goals that serve the DAO's values. Without knowing the architects' intentions beforehand, we should be able to observe the functioning of a system at steady state, and guess the original intentions of the architects. Put another way, it doesn't matter what the architects' intentions are, the resulting rules of the game tell the players what to value. So, if you don't value what a DAO encourages you to achieve, you shouldn't join. Put another way, if you know what your values are, you should design the DAO so that it rewards actions which achieve goals reflecting those values, and punishes actions which hinder such achievements.

In this section we will identify a few choices in DAO governance design and match them to some basic values that DAOs may choose.11

Connecting values with protocols

We specify several desirable qualities for a DAO and identify several protocols which encourage each quality.

A general point of view from game theory is that even if a particular behavior is only slightly favored in each round of a repeated game, it is strongly favored in the long run and so dominates behavior and outcomes. For example, the house has less than a 1% advantage in blackjack gambling in typical casinos, yet the game is an enormous source of predictable profit, as demonstrated by the ostentatious display of wealth in Macau or Monte Carlo or Las Vegas. Therefore, changing governance parameters, only slightly, should be enough to steer long-term member behavior toward the goals of the DAO.

The basic protocols that determine how power is distributed comes from four stages:

How workers are chosen for a task.

How members are able to judge a task and how reputation is distributed according to the judgment.

How the profits are distributed to the members.

How reputation is reviewed.

First, we explain how different types of distributive norms (i.e., standards for how power is shared and apportioned and adjusted in a group) may be encouraged with

[11] For a more thorough technical introduction, see Craig Calcaterra, On-Chain Governance of Decentralized Autonomous Organizations, (May 2018), available at https://ssrn.com/abstract=3188374. (Retrieved June, 2020)

particular choices of parameters. Next, we discuss how parameters may be set and how they might evolve for a toy model of a basic company's life cycle.

Distributive norms

To encourage harmony, careful attention must be paid to the manner in which power and wealth are distributed in any DAO. Subtle changes in the governance structure of different DAOs can encourage many types of distributive norms. A distributive norm is a standard for sharing wealth and power within the organization. Typically, for small, newly founded DAOs, the standard will be equity to encourage members to join, but this would change to favor meritocracy, as the DAO matures and wants to encourage improvement. Other norms which encourage different behaviors can also be incentivized with the appropriate choice of protocols. We explore the effects of parameter manipulation on six categories of distributive norms.12 These separate norms conflict or overlap with each other, but a complex network will typically merge several different norms to balance the needs of its members.

Distribution Proportional to Input (similar to Legal Equity): 13 Under this distributive norm, members' outcomes should be based on their inputs. Under this norm an individual who has invested a large amount of input (e.g., time, money, energy) should receive more from the group than someone who has contributed little.

This distributive norm will be typical for early DAOs focused on business enterprises. This is encouraged with the basic default setup described previously in Chapter 4.3 and 6.3.

Reputation-weighted random selection of workers.

Reputation-weighted voting and rewards in validation pools.

Reputation-weighted salaries.

Distribution Proportional to Result (Pure Meritocracy): instead of measuring how much energy the individuals contribute, you measure how their efforts have improved the organization, and reward them proportionately.

⍰⍰

[12] These categories closely follow those described in Donelson Forsyth, *Group Dynamics*, 5th Ed., pp 388 – 389, Cengage Learning, (2006).

[13] The term equity has different interpretations in different contexts. Social equity can mean historical issues are accounted for and so those who were given less in the past are given more in the present. This overlaps largely, but not entirely, with equity in economics. The goal might be to give members the power that most allows them to contribute to individual and group welfare, or the goal may be to level all power. Legal equity can mean many things, including that past powers should be protected, since different properties or assets are never perfectly fairly interchangeable. Throughout this book we have used equity in the sense from economic theory, where those with less are given more.

This is encouraged with the basic default setup described above, with the addition of

Reviewing previous contributions according to analysis of results. Reputation is augmented or reduced appropriately. (See Chapter 9 for further discussion of the details of how reviewing can be automated in a DAO.)

Equal Distribution of Output: Regardless of their inputs, all group members should be given an equal share of the rewards/costs. This requires that someone who contributes 20% of the group's resources should receive as much as someone who contributes 60%.

This can be incentivized by

Random selection of workers according to membership, not reputational holdings.

Equal votes and rewards in validation pools according to membership, not reputational holdings.

Equal salaries for each member.

This is impossible to maintain under the current technology with open access and privacy, since sockpuppet accounts would be abused. Improvements in ZK proofs and identity protocols, however, will soon make it possible to efficiently and securely combat such sockpuppet attacks.

Distribution to the Powerful: Those with more authority, status, or control over the group should receive more than those in lower level positions.

This norm may be achieved by maintaining early users' majority power by skewing reputation-weighted power to further advantage those with more reputation in 1) random selection of workers, 2) voting and rewards, and 3) salaries. Reputation can be treated as an artificially scarce resource, continually decreasing how much is minted, making it more difficult to earn and more valuable as time goes by. This makes the economy of reputation tokens deflationary.

Distribution from the Powerful (Responsibility): Group members who have the most should share their resources with those who have less.

Reversing the previous distributed norm may be promoted by instituting several possible hard protocols which periodically redistribute power by:

Actively transferring tokens.

Passively redistributing tokens by

destroying all reputation tokens as they age (deflates the reputation economy)

increasing the rate of reputation minting as time progresses (inflates the reputation economy)

Distribution According to Need (Equity in economic theory): Those in greatest need should be provided with resources to meet those needs. Such individuals should be given more resources than those in possession, regardless of their input. The goal is to equalize the power of all members.

This norm is promoted using the methods described in Equal Distribution of Output, and Distribution from the Powerful. Again, such a system can obviously be abused in an open distributed setting through sockpuppet attacks if complicated policing is not instituted.

A more sophisticated governance structure will switch between norms as the DAO matures, or in response to market changes, as discussed next.

Company life cycle

Now we illustrate the effect of adjusting three parameters of reward distribution for encouraging different behaviors in the course of a company's life cycle. This illustrates an implementation of dynamic governance in a decentralized organization thanks to decentralized information processing.

We use the toy model of the Software Review DAO described in Chapter 4. The three parameters control

how fast new reputation tokens are minted

how much the new reputation tokens reward work versus policing work

speed of debate, as the voting moves from loosely coupled to tightly coupled.

The life cycle of this toy model DAO is split into 5 stages. It starts with protocol development from the founders. The next stages are member recruitment, collecting evidence of expertise, attracting fees, and finally policing work in the equilibrium stage where the DAO collects the most fees. In practice, there would be more stages which would repeat and overlap. Further, each division of a company (each expertise) will not experience the same stages contemporaneously with other divisions.

Stage 1: Protocol development

The DAO first must decide how the group is organized, how power will be shared, what regulatory and legislative governance process will be used. Second, the DAO specifies how to perform software analysis—what logical and statistical tests are used on what types of software. Third, protocols for validating another expert's work are specified. Such protocol development is encouraged by setting parameters as follows.

Highest. The DAO is not attracting public fees until Stage 4, so reputation tokens are minted in proportion to minimal DoS fees paid entirely by the poster. Therefore, the ratio of newly minted reputation tokens is set to the highest value for these posts, to encourage protocol development and reward the founders.

Highest. The percentage of newly minted tokens is shared more with workers proposing new protocols more than those policing the new protocols.

Longest. The small founding group is expected to be highly collaborative so contentious debate posts should move quickly to non-contentious posts, establishing precedent. However, this is the stage that should require the longest period of time

to settle differences. I.e., these should be the longest periods of time between loosely coupled votes to tightly coupled votes, as the protocols move from soft to hard.

Stage 2: Talent recruitment.

Once the founding members have established satisfactory reputation holdings, the DAO will recruit more software evaluator experts, requesting applications to be posted to their forum for validation. The parameters are set as follows:

3rd highest. The proportion of reputation tokens minted from the minimal DoS fees paid by the recruit will be set to determine a recruit's initial reputation holdings will be high.

The percentage given to policing is 50%. Policing is important at this stage, and new members shouldn't overwhelm founders' reputation.

Short. Debate on the recruit's application will move quickly from loosely-coupled to tightly-coupled to force consensus in a reasonable time period.

Stage 3: Collecting evidence of expertise.

Experts advertise their credentials and produce work-evidence posts without collecting public fees—evaluating software for free. They will be posting with minimal DoS fees, so the parameters are set as follows:

2nd highest. Members are doing work for free, so newly minted reputation should be much higher than the DoS fees they pay to participate in the group.

The percentage given for policing is 50%. New contributions are important at this stage, but so is policing. New contributions of evidence of expertise shouldn't overwhelm founders' reputation for protocol development.

3rd shortest. Debate is rare and short. Most cases should have been settled by the protocols developed in Stage 1. These posts should move quickly to tightly-coupled and non-contentious votes.

Stage 4: Attracting fees.

Once a body of work is established, this stage requires a new effort to attract customers, both general public and software companies which send fees. The parameters are set as follows:

4th highest. Newly minted reputation is minted in higher proportion to the fees, to encourage enterprising effort.

The percentage given for policing can be higher than 50% if protecting the expertise is more important, or lower than 50% if the DAO is more interested in attracting customers.

2nd shortest. Debate should be almost nonexistent, with the only doubt being whether the fees are corrupting the DAO.

Stage 5: Policing work

This is the desired equilibrium stage of the company. Members are attracting fees from off-chain work for software companies and posting work-evidence to the forum for validation. The protocol is that a company downloads a template request for work

(RFW) smart contract that the DAO has written and posted to their forum and chooses several parameters that the DAO has suggested, including the amount of work requested and the fee they are willing to pay. This RFW smart contract selects a random DAO member for off-chain analysis of their product. This random selection requires DAO members to have already posted availability stakes using their own availability smart contract, which encumbers part of their reputation holdings to be engaged for off-chain work. The randomly selected availability-stake smart contract engages with the RFW smart contract to allow the selected reviewer to post their review to the forum for validation, with the fee sent in their name, so that half of the newly minted reputation tokens are staked in the reviewer's name. The fee from the software company is distributed to the DAO in the reputation-weighted salary. The parameters are set as follows:

Lowest. Newly minted reputation is minted in proportion to the fees. This is the stage where reputation gets its meaning.

The percentage given for policing is 50%. This is the standard for maintaining the value of the reputation. This can be adjusted to respond to market changes to encourage policing or working.

Shortest. Debate should be nonexistent, with protocols followed algorithmically.

After the Stage 5, the life cycle of the DAO will repeat as innovation research requires new protocol development to keep the organization relevant to the changing market.

Deciding how and when to move between the stages is a matter of debate. Legislative governance (previous section) is required to develop a system for making those executive decisions in response to changes in the DAO and the market.

Microdemocracy

Representative democracies in the 21st century are revealing weaknesses in their age. Delegating one's vote to a third party without solid information about their ethics or belief system is unwise. Delegating too much power to an individual or a party naturally leads to corruption as smaller groups advantage themselves above the greater good. It worked in the 18th century because social life was much more uniform and enmeshed on a local geographical level. People spent much more time and energy communing and monitoring their neighbors. In developed countries today, it is less likely you will know your neighbors' names, much less their detailed moral stances and political views. Without the ability to hold them to account, representatives are not incentivized to vote for outcomes that reflect the presumptive wishes and needs of their larger constituency, but for promoting the agendas which benefit their personal interests and maintaining their own power.

If we wish to delegate power, it should be given to people or groups that you know and respect, communities you have spent time building without being limited to geographical proximity or ethnic identity. These issues with representative democracy are eliminated with direct democracy.

Voting incentives and outcomes are different under direct democracy. In Ancient Athens, for example, citizens voted on any public issues directly on the town's square. Public issues as significant as whether to go to war or as mundane as where to build the next road would be decided by oral acclamation. Incentives, voting outcomes, and democratic legitimacy are aligned. Democracy is increasingly under threat and needs upgrades. However, information technology determines the limits of effectiveness and scope of any system that uses it.

Ancient Greek direct democracy, using the primitive information technology of the spoken word, was limited to the size of a village. And direct democracy led to significant problems. The loudest and most persuasive people held the most sway. This led to schools devoted to training aristocratic children in manipulative rhetoric, sophistry. To combat such manipulation, competing schools trained children in logical tools for identifying and deconstructing sophistry. And so the Greeks invented analysis and philosophy, to defend their civilization, and themselves, from lies.14

[14] Like any historical story, this one is also a simultaneous simplification and exaggeration. Aristotle referred to other experiments, but the first detailed records of Greek democracy are from Athens, which technically had a representative democracy, though representatives were probably selected randomly using the *kleroterion* (see footnote 153).

Though the word "analysis" is etymologically Greek, the idea is certainly as old as civilization, but probably much older. One of the oldest stories in history is the Babylonian creation myth, *The Enuma Elish.* Committed to writing some 1500 years before Athenian democracy, the story faithfully recounts the process of modeling, analysis, and synthesis.

The Babylonian god-king Marduk has an array of weapons he uses to confront the threat of chaos, particularly magic words (spells), a magic net, and a magic sword. The chaos monster, Tiamat, is initially represented as the world-circling ocean. Marduk uses his magic words to force Tiamat into the definite form of a dragon that can be grappled with. His magic net then captures the dragon, he chops up the captured monster into pieces, and uses those pieces to build the very structure of society and tools for its use.

The magic words that cohere the ocean of chaos into the definite form of a dragon is the first step of the modeling process, i.e., choosing the right context. Capturing the dragon with the magic net is the process of establishing the mathematical existence, uniqueness, and stability of solutions to the model. Analysis is the process of dividing or cutting apart the model into its basic elements. Synthesis is the process of forming new structures from these constituent pieces, to gain new forms of control. Finally, the point of repeatedly telling this story is to give us an example to follow, making us confident we can reenact its stages at any time in the future when the chaos monster comes back in a new form. This is extensibility of the model. Cf., Erich Neumann, "The Origins and History of Consciousness", 1954. One of Marduk's many names was "He Who Makes Ingenious Things from Combat with Tiamat".

With the success of direct democracy, groups grew in power and size, beyond the capacity for people to govern by shouting at the agora, beyond the limit of how many can fill an amphitheater. As villages grew to cities, direct democracy failed to reflect the will of the group. There is a limit to how many people can speak, even at an amphitheater, because there is a limit to peoples' patience and endurance. To overcome the technological limits of information transmission through shouting, democratic societies devised a system of representative democracy, where a select group of representatives—as many as could convene together physically and communicate—would make decisions on behalf of their larger constituency. People were quite aware of the natural downsides of democratic delegation, such as corruption, bribery, and biases before representative democracy started, but the advantages of the network effects of a larger population were well worth the overhead cost of policing such frictions.

Decentralization disperses concentrated power, delegated power, returning it to the individual members of the network. Contemporary decentralized information technology enables direct democracy at scales larger than our modern national representative democracies. Contemporary technology no longer limits our ability to communicate to the number of people who can fit in a room and patiently wait for their turn to speak. With the advances in information transmission, storage, and especially information processing we can now register our opinions on the smallest matters, store them for asynchronous consideration, and broadcast our responses globally. The power of our individually owned computers, with millions of cycles per second, allows us to process this information using complicated algorithms without relying on a centralized bureaucracy to analyze the information. The limits of our perception make it seem as though our devices can continually post our votes on the most minute concerns. They continually signal where we are, what we are buying, and what our heartrate is. Our devices can signal our will on the most minute matters, creating a new level of direct democracy. Microdemocracy.

Microdemocracy and proper incentive design can increase the voter participation that undermines representative democracies. Experimentation with electronic forms of voting allows new forms of allocating votes to prioritize societal issues for each voter.[15] The more important a given societal issue is for a given voter, the more effort

[15] Quadratic voting, for example, allows a first glimpse of the innovations that are possible with microdemocratic systems. In this scenario each voter is periodically allocated a limited number of vote tokens. These tokens may be spent to vote on any issue the voter is concerned with during the period. If you allocate more vote tokens, you have a bigger influence in the outcome than someone who allocates less, signifying the priority you place on the issue. Lalley and Weyl argue the ideal way to count the votes is quadratically. That is, you can spend 1 token for one vote, but 4 of your tokens are needed to register 2 votes, 9 tokens for 3 votes, and so on. They argue this inhibits negative effects that harm

or power the voter will allocate to the issue. For example, as more and more people become aware of the climate crisis faced by humanity, they will increasingly allocate their votes on issues that reflect their increasing awareness. Change is realized as people allocate their votes prioritized by their preferences and awareness. Moreover, part of the power of this microdemocratic approach derives from the higher levels of knowledge a given voter has on a particular issue that is evidenced by the voters' proportional attention. It is less likely that voters will engage with issues they know relatively little about. The discovery of the will of the electorate is improved, and previously disenfranchised constituencies are empowered.

Microdemocracies must address the problem of the Tragedy of the Commons. In microdemocratic systems, individual voters act independent of the totality of voters according to their self-interest. Acting for their own self-interest may be contrary to the common good of all voters. Without controls, some self-interested voters may be depleting or spoiling resources they share with the rest of society, such as the environment or public goods. Similarly, majority rule may mean discrimination against the minority. As discussed above, The Tyranny of the Majority happens naturally, and must be policed consciously in a microdemocracy. Perhaps the best way to protect minorities is to make more of them, by promoting the natural diversity of interests in humanity by empowering individuals. Rights protecting minorities must be enshrined in any overarching rules, and protected by nurturing values which respect diversity and individuality.

A key advantage of a microdemocracy is the speed with which it can enact change. In the early 2020s, representative democracies are largely slow and inflexible because their constitutional and legal infrastructure were designed decades or centuries before contemporary information technology was invented. Large-scale political change typically depends on the election of a new government after, typically, around 4 years. By contrast, microdemocratic voting would provide a more immediate feedback system between voters and their representatives. Because decentralized technology enables the transparent and incorruptible tallying of votes, nearly instantaneously, voting can be more dynamic and incremental and political will can be exercised more directly.

other systems. Tyranny of the Majority results from one-person-one-vote schemes, but this is inhibited if one person can register their greater concern by devoting more of their voice on one subject. In this way minorities can override majorities on issues they are most concerned with. At the same time, quadratic voting inhibits the Tyranny of the Interested Party, as it limits those with the greater concern on subject from dominating the group, because their megaphone is muffled by the requirement of expending more and more vote tokens to register each new vote. Steven Lalley & Glen Weyl, "Quadratic Voting: How Mechanism Design Can Radicalize Democracy", American Economic Association Papers and Proceedings, Vol. 1, No. 1 (2018)

Decentralized technology can improve voting technology in representative democracies. Voting technologies in existing representative democracies were woefully outdated at the beginning of the 21st century. Since the 2000 U.S. Presidential election16 which necessitated reexamination of punch holes in paper voting cards, existing voting systems with analog or paper technology have been proven suboptimal. But the problems with existing voting systems do not end with technology. Redistricting or gerrymandering, that is, manipulating the boundaries of a voting district to affect voting outcomes, and other issues such as election financing show that voting and the democratic institutions built to facilitate basic tenets of representative democracies have been under attack and require updates. Decentralized technologies have technological features that can provide solutions. But, such solutions also require political will. For example, voting on a public blockchain that overcomes the trilemma of blockchains (decentralization, scaling, security) may become a core application of the technology. Decentralized technologies have the capacity to change the incentive design for voting which helps address some of the dangers presented by existing internet voting. And computer security is strong enough to maintain privacy, yet allow transparent, publicly auditable, records through zero-knowledge proofs as demonstrated by Bitcoin's $100 billion decentralized protocols.

Decentralized technologies provide inherent microdemocratic features that can help instantiate microdemocratic principles and processes in society. Decentralized technology enables smaller scale democratic decisions at unprecedented scale. In the early 21st century, internet platform businesses and social media companies inaugurated new forms of voting. The "Like" button, while deeply flawed in its incentive design and voting-related outcomes, inaugurated a new form of voting on social outcomes and, at the same time, trained the voting public to engage more directly with voting-related outcomes. Decentralized technologies create extensions of these forms of more direct democratic votes. Unlike their centralized predecessors, decentralized technologies, for the first time in history, enable improved incentive designs that help overcome the insufficiencies in voting outcomes of representative democracies. As voting pools in decentralized systems increase, deepen, and diversify, they can become supplemental voting systems that help overcome the lack of legitimacy and improve representative democracies.

The printing press taught the people how to read. The internet is teaching people how to write. Decentralized technology will teach people how to vote.

Of course, such upgrades to existing representative democracies will require establishment governmental support—the existing representatives must vote to change

⍰⍰
[16] Bush v. Gore, 531 U.S. 98 (2000).

the structure that brought them to power—which is dubious. Again, large decentralized organizations are very stable. It's more likely that organic advances in decentralized networks will make the established institutions irrelevant until they are bypassed and ignored. This is not a problem if we build all the hard-earned social protections into the new decentralized networks. That can only happen if we consciously work to protect these historical advances of civilization while promoting the diversity of humanity by empowering individuals.

Summary

The goal of this chapter was to introduce governance design and analyze the consequences of different protocols for promoting the chosen values and goals in any particular DAO. The goal of these solutions is to make it easy to participate for the maximal number and types of users throughout the greatest variation of DAO goals. Users should not need to be technological authorities to navigate the system and add value. In the vast majority of cases, for the vast majority of users, the user interface (UI) will hide all of the details discussed. An intuitive UI can recommend posts and allow users to quickly evaluate post after post, staking varied amounts of their limited reputation in varied degrees of tightly- and loosely-coupled votes. How the system actually counts the votes and determines the reward structure for references will determine what values and goals are promoted in any particular DAO. Though the reward structures will be openly available for any DAO, the members will soon become experts on how to effectively navigate the system without poring over the technical details, merely from repeated use.

Weighted democracy is crucial for solving the Tragedy of the Commons and Tyranny of the Majority problems. For example, Dr. Craig should have more weight than the average person in the decision on which new math classes to run in the Fall at Metropolitan State University. Craig's vote is not equal to your vote, Dear Reader. Similarly, the average Metro State student should have more weight than the average Minnesotan on this issue, but less weight than a math major's vote. Finally, the average American should have more weight than the average South American. In our imagined perfect system, the average South American would still be able to register their opinion about what classes should be offered in Minnesota, as long as they are interested in the subject and willing to stake their reputation to influence the vote in a positive way. But their opinion would have much less power than a professor who works at the school. One person one vote is not the right way to govern on every issue.

This may seem like fantasy, where a global weighted democracy could register such disparate opinions on globally trivial details and filter that information down to meaningful governance, but the technology is already in place. People already curate

valuable information on supranational platforms with their reputation. With more than 10 million global users, Stack Overflow is a centralized Web 2.0 company that leverages the power of decentralization through the internet to build knowledge bases for many subjects including computer science and other technical disciplines that is relied on by many practicing experts. Similar to Reddit's reputational system, users' reputation grows in proportion to their contributions through questions, answers, and comments in proportion to others' upvotes and downvotes.

The only thing missing is that the system doesn't share power with their users. Since Stack Overflow and Reddit and Facebook and Twitter and all the other successful social media sites are privately, centrally owned, their governance processes—their algorithms for distributing reputation—are necessarily opaque. This is because the incentives are not properly aligned for their users to police their own reputation against gaming. Some of the idealistic users would certainly try to police the site from sock-puppet accounts and malevolent groups if they were given more power in a transparent system. But the millions who are not financially invested in the system would not have the proper motivation to fight against the few hackers who could exploit the system for profit using the same information technology processing abilities we propose to empower all users with. When it's more profitable to game the system than protect it, the centralized organization needs to keep the underlying protocols opaque to maintain the system's integrity. But that type of centralized regulation is not as dynamic and responsive as a decentralized governance process would be if it empowered its users to develop protocols to fight gaming.

We have the power, now, to track and audit such seemingly trivial choices as what a pseudonymous Bolivian thinks about the class offerings in the math department of a university on another continent. We have the processing power to weight those opinions based on their earned reputation, and to control how they effect the ultimate decisions. We have the computational power to institute sophisticated weighted-democratic governance protocols on a global scale for trivial matters, to fairly and efficiently adjust reputational power to encourage productive cooperation.

Eric Raymond famously said, "Love doesn't scale." He was arguing that capitalism, not socialism, is necessary for giving people the proper economic incentives to keep business working together to supply larger society with the resources necessary to survive. He was referring to how we may behave altruistically toward our family and friends, but when it comes to economic decisions on the global stage, you can't count on a democracy to make decisions that benefit all when local individuals could profit at their expense. One-person-one-vote loses coherence as it scales up to a global democracy.

Love doesn't scale, but reputation does. Weighted democracy, properly measured and aggregated, can scale from valuating expertise on a local level to expertise on global issues. If you find the right balance, if the valuations of reputation tokens

between distinct DAOs find the proper equilibrium through market freedom, the various reputations can achieve coherent meaning for making decisions at the global level. The math required is basic arithmetic. The elementary logic is more than 4,000 years old. Contemporary information technology can handle the demands of global decentralized governance. We simply need sufficient investment in transparency and democracy and individual autonomy—in decentralization—to pull it off.

Bibliography

Formating example:

Evans, Dave (Apr. 2011). The Internet of Things: How the Next Evolution of the Internet is Changing Everything. CISCO White Paper, https://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf (accessed June 1, 2020).

Wikipedia. Last Universal Common Ancestor, https://en.wikipedia.org/wiki/Last_universal_common_ancestor (accessed June 1, 2020).