Gitcoin Through the Lens of Systems Science

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Abstract

Systems science is an academic discipline whose methods are widely used, but which remains underdeveloped. This is largely due to the lack of a unifying theoretical framework and formal methodology that all practitioners use. George Mobus and Michael Kalton have proposed twelve basic principles of systems science which serve as the foundation for a formal methodology for deep systems analysis. Using the principles as a conceptual framework for analysis can help us gain holistic understanding of any system of interest. Examining Gitcoin, a cutting edge complex socio-technical system dedicated to supporting digital public goods, through the lens of these principles demonstrates the utility of identifying a set of universal principles that apply to all systems. Applying the principles to an analysis of Gitcoin facilitates a deep understanding of Gitcoin. It also helps foster appreciation for the power of principles and a sense for how they can be applied to any other system. The twelve principles outlined by Mobus and Kalton are a promising candidate for a set of principles that the incredibly fragmented systems science community can unify around. Greater unification is necessary if the discipline is to advance, be taken seriously, and reach its full potential. Society needs a mature discipline of systems science to deal with the complex systemic issues we face.

Twelve Principles of Systems Science

Systems science is the interdisciplinary study of systems.[1] Individual practices of systems science such as network science, agent-based modeling, and systems dynamics modeling are widely accepted as useful scientific methodologies. They have been effectively used to help shed light on the complex dynamics of issues ranging from the US-China hegemonic transition[2] to the spread of infectious disease[3] and homelessness.[4] However, each of these techniques can only reveal certain aspects of a given system. There is currently no unified discipline of systems science being taught that provides a formal methodology for rigorously exploring all aspects of a system in a holistic manner.

George Mobus and Michael Kalton have identified twelve basic principles[5] which serve as a theoretical foundation for developing such a formal methodology.[6] These principles are a set of fundamental laws that apply to all types of systems.

The first five principles describe **basic properties of systems; what systems are.**

#1 Everything in the observable universe is a system.

#2 Systems are processes organized as hierarchies.

#3 Systems are networks.

#4 Systems are dynamic.

#5 Systems exhibit complexity.

The next five describe the **operation of systems; how they behave.**

#6 Systems evolve.

#7 Systems send and receive information, and encode knowledge.

#8 Systems use governance subsystems to achieve stability.

#9 Systems build models of external systems.

#10 Systems build internal models of themselves.

The final two describe **how humans can relate to systems to achieve their goals.**

#11 We understand systems using science.

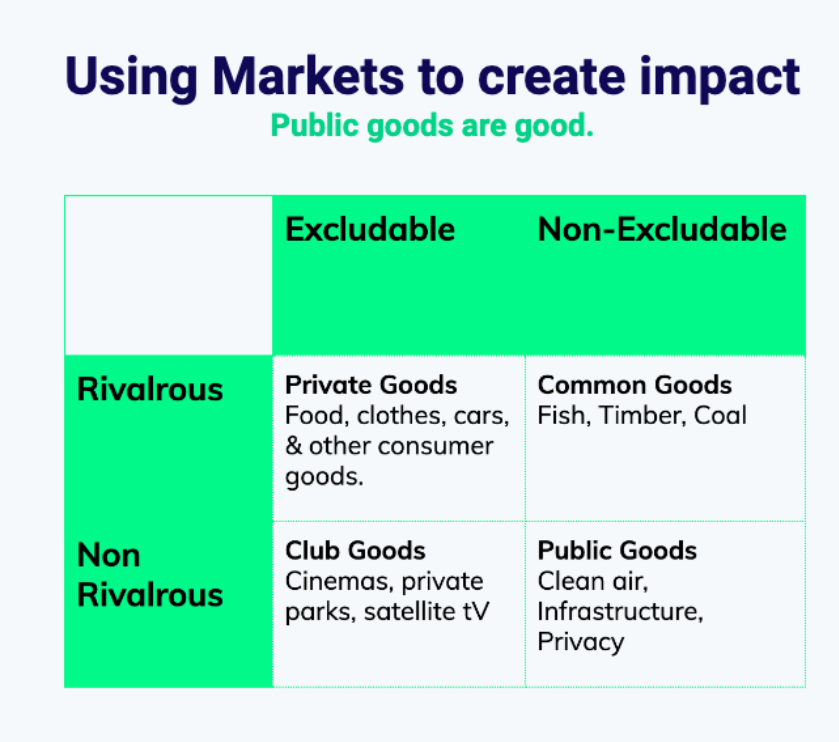
#12 We improve systems using engineering.

This essay will demonstrate how using the twelve principles developed by Mobus and Kalton as a conceptual framework can help researchers and practitioners achieve a holistic understanding of any system. Specifically, we will be examining how these principles apply to the Decentralized Autonomous Organization(DAO) known as Gitcoin.

Why is Gitcoin Worth Studying?

Gitcoin[7] is an online platform powered by the Ethereum[8] network which is dedicated to the building and funding of digital public goods. These public goods are freely available products and services that can be used and modified by anyone, such as open-source software, data sets and freely available educational content. Since its launch in 2017, Gitcoin has facilitated over $72 million[9] of funding for digital goods and services.

The organization's success demonstrates that **cryptonetworks can facilitate large-scale, opt-in, voluntary funding of public goods.**[10] Public goods are goods that are "non-rivalrous" and "non-excludable." This means that one person's use of the good doesn't diminish the capacity for someone else to use it, and there is no practical way to prevent any specific person from using it.



Source

Gitcoin's experimentation with novel forms of public goods funding is important because traditionally, many necessary public goods have relied on government taxation for funding. As a result of this dependency, public goods are often underfunded, and the tax-payers supporting them don't have a direct say in how their money is spent.

Gitcoin provides much-needed support for the financing of open-source software, a specific type of digital public good that is "vital to the functioning of governments, private companies, and individual lives," but is "built and maintained almost exclusively by unpaid volunteers."[11] For example, OpenSSL, a software library that a majority of all internet servers and websites rely upon for secure communications and payments, depends on volunteers, donations, and private funding to pay for the developers that maintain it. Despite being a piece of critical infrastructure that countries need to keep their economies running, OpenSSL has often struggled to find the funding necessary to stay afloat.

Gitcoin is governed by a DAO, an entity that, in the words of Ethereum co-founder Vitalik Buterin, "lives on the internet and exists autonomously, but also heavily relies on hiring individuals to perform certain tasks that the automaton itself cannot do".[12] Gitcoin does not have a centralized physical headquarters. All coordination within the organization takes place remotely online. Anyone in the world can participate in Gitcoin's governance by purchasing its governance token (GTC) on open markets and joining online discussion channels. Organizational policies and procedures are governed by smart contracts, which are pieces of code that are completely transparent.[13] Once deployed to a blockchain, a smart contract will run exactly as initially programmed and can't be modified or controlled by users or the programmers that created them.

It is important to gain a deep understanding of the benefits and shortcomings of the DAOs that are rapidly growing in size and influence because they could "have a significant impact on the way firms are governed—both by digitizing traditional governance mechanisms and by offering fundamentally new ways of organizing business enterprises."[14] Gitcoin founder Kevin Owocki argues that DAOs are a more legitimate basis for public-goods centered missions than companies because consent flows from the governed.[15] From the users, rather than from shareholders, and up to the board or CEO.

Researchers, policymakers and entrepreneurs should be interested in the success of Gitcoin because it is an innovative and powerful system that has the potential to drastically change humanity's relationship to public goods for the better. Gitcoin is demonstrating that we don't have to depend on governments to provide large-scale funding of public goods, we can empower individuals to directly support the types of goods they care about. We can provide communities with a variety of tools for supporting public goods in ways that meet their needs.

Principle 1: Everything in the observable universe is a system

"*Bounded networks of relations among parts constitute a holistic unit. Systems interact with other systems, forming yet larger systems. The Universe is composed of systems of systems."*

A system is a network of relationships among parts that constitute a whole. The first principle of systems science states that everything in the observable universe can be understood simultaneously as a system *and* as a component of larger systems. A cell is a system composed of molecules, which are composed of atoms, which are composed of sub-atomic particles. Cells are also subsystems within organs which are subsystems within humans which are subsystems embedded in families, cities, states, nations, the earth, the solar system, the milky way galaxy, and the universe. The metaphysical assumption that the universe is a system of systems is the foundation upon which the other principles rest. Everything can be understood as a system, and there are certain properties which are common to all systems.

Understanding Gitcoin requires both deep analysis of Gitcoin itself, its internal components, and a holistic synthesis that studies how it operates within the web of external systems it is embedded within and interacts with.

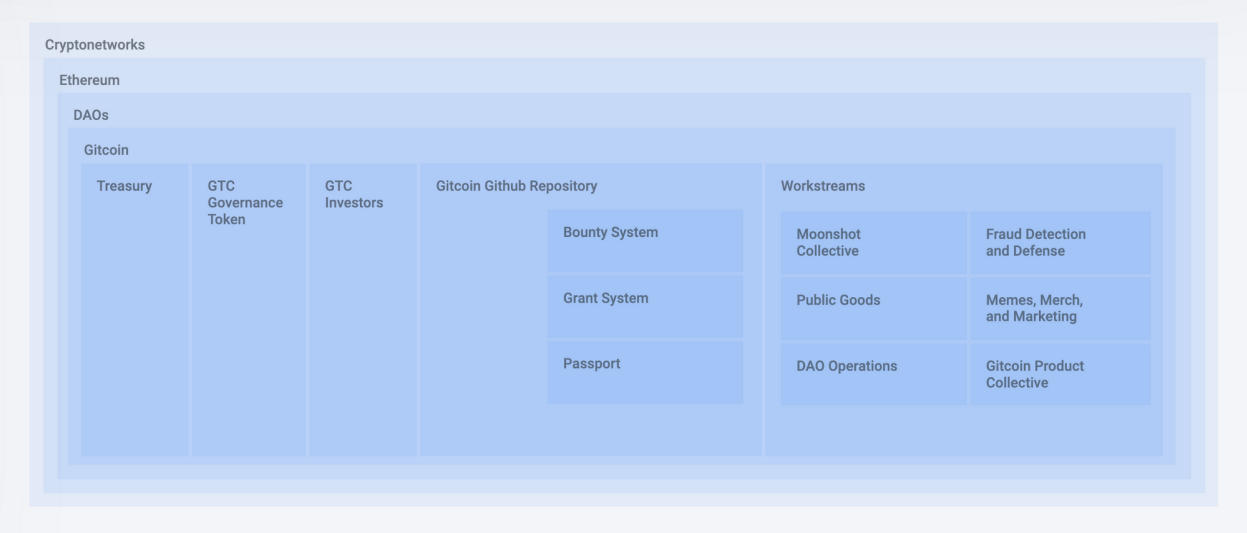
Gitcoin is made up of several subsystems. The community consists of 22,000 GTC holders,[16] 25,000 members in its Discord server,[17] and 7,000 members in its governance forum.[18]

Workstreams are groups of contributors focused on specific organizational tasks.[19] A Github repository contains software that powers the Gitcoin platform.[20] A set of smart contracts power the DAO's organizational operations.[21] The DAO's community-governed treasury holds $41 million (at publishing time) worth of GTC tokens. [22]

Gitcoin is both a key pillar of, and exists within, the Ethereum ecosystem. The Ethereum ecosystem is the set of users, developers, and entrepreneurs that build and interact with Ethereum-based applications. Several of the most widely used and influential Ethereum-based projects have been

able to succeed thanks to Gitcoin Grants funding, such as the media organization BanklessDAO[23] and popular Ethereum client Prysm.[24]

Ethereum exists within a broader ecosystem of all cryptonetworks. All cryptonetworks exist within a vast and complex global political economy composed of governments, international corporations, and private/central banks. The global political economy exists within the whole system of the Earth itself.



Principle 2: Systems are processes organized as structural and functional hierarchies

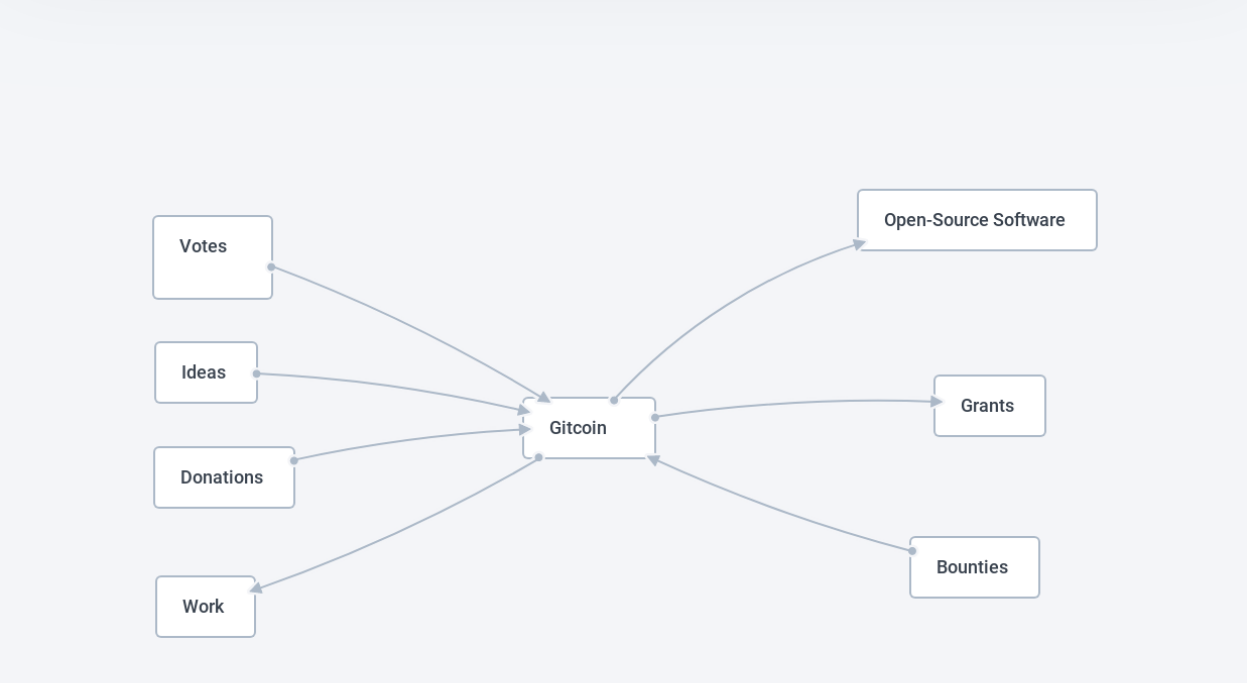
All systems can be understood as processes unfolding over time. In this sense, the words “system” and “process” become synonymous. Viewing systems as processes invites us to see them as *objects* which turn inputs into outputs, and to look at the interactions among the internal components which allow this to happen.

Even systems that are typically thought of as inert, such as a rock, are actually *dynamic* processes. Rocks take water seepage and thermal variations as inputs, and then shed flakes, such as silica, which create sand and clay as outputs. Mountains are open to dynamic processes such as how the shifting of rocks can create an avalanche, changing the shape of the whole. Each system is both composed of subsystems and acts both dynamically and statically depending upon the level of analysis.

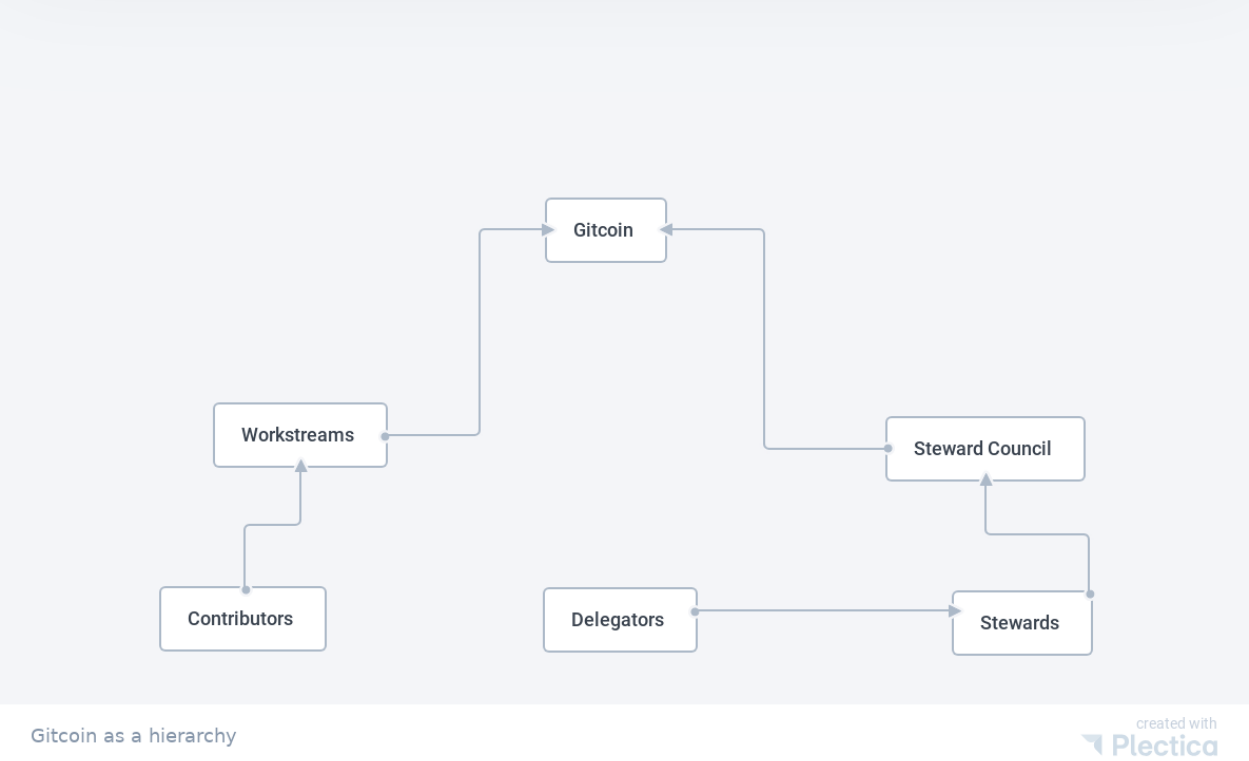
Gitcoin takes inputs such as votes, bounties, ideas from contributors, and donations. It turns them into outputs which include grants and digital public goods such as open-source software.

Turning inputs into outputs requires systems to use hierarchies for organizing their work. A hierarchy is a layered structure in which the lowest layer is made up of the structure’s simplest components.

The higher layers of the hierarchy aggregate information which is derived from the operation of the lower layers. Each component's place in the hierarchy corresponds with and determines its function.



Gitcoin as a process



Gitcoin as a hierarchy

There are three main sub-systems that enable Gitcoin to take inputs and use them to produce digital public goods.

The Gitcoin bounties platform connects individuals and organizations that need help with specific tasks with people that are looking for work. Requests for work are inputs, completed tasks and paid bounties are outputs.

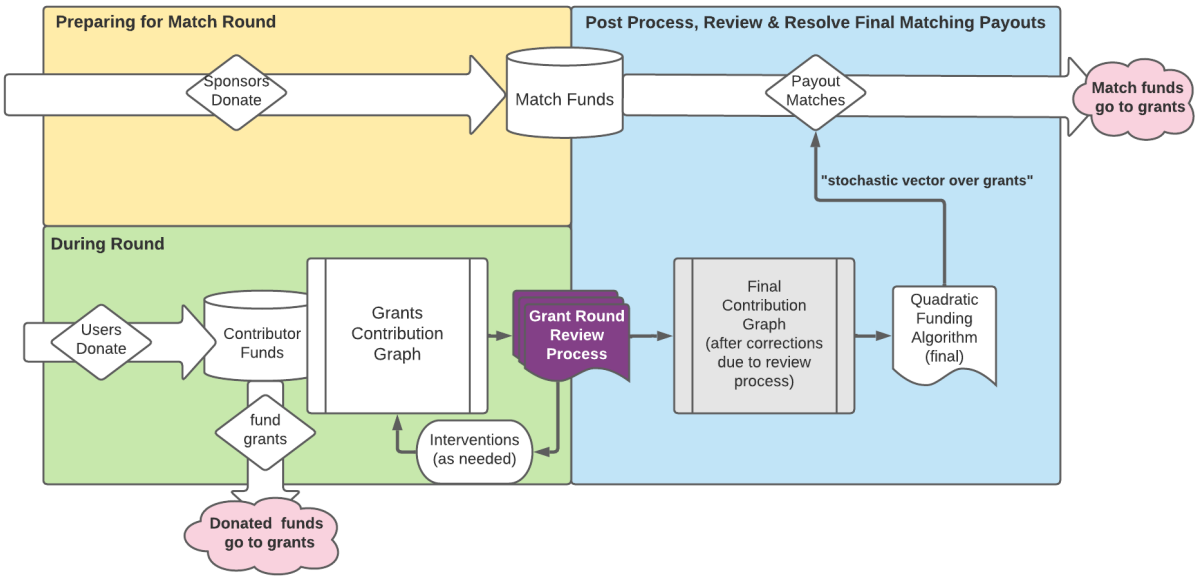
Gitcoin hackathons connect sponsors that are looking for developers to build on top of their open source protocols with developers seeking to earn money. Project and feature requests are the inputs, prize money and software are the outputs.

Gitcoin Grants is the core process that produces the most value for Gitcoin and its users.[25] Gitcoin grants is a platform that helps organizations get funding for public goods projects they are working on. Grants rounds are run once every quarter and last for two weeks. Project owners input project descriptions and grant applications, and donors input money. Project owners then receive grants as outputs.

Gitcoin Grants rounds use a **Quadratic Financing** mechanism to ensure that the preferences of the community are expressed, not just the desires of wealthy individuals.[26] There are two types of grantors in this system: individual grantors, and matching partners, which are large organizations or institutions that contribute funds to a “matching pool”. Funds from the matching pool are distributed to the projects that get support from the most individual donors. If one person donates 100 dollars to a project, that project gets minimal funds from the matching pool. Whereas if 100 people each

donate one dollar, that project would be matched with a large amount of funds. Quadratic Funding (QF) is "the mathematically optimal way to fund public goods in a democratic community."[27]

The following diagram visually depicts the major processes involved in transforming donations into grants.[28]



Ecosystem Mapping & Discussion

At the lowest level of the Gitcoin hierarchy there are three different formal roles for individuals.[29]

Contributors are community members who dedicate their time, talent, and expertise to workstreams to help Gitcoin accomplish its mission. *Delegators* are community members who hold the GTC governance token, but delegate their voting rights to stewards who exercise power for them. Stewards are community members who serve the community by exercising voting power that has been delegated to them, and by managing workstreams.

At the next level up there are subsystems composed of groups of individuals. Workstreams each have their own budget, leadership structure, tools, and procedures. The Gitcoin Product Collective focuses on product development, while the Public Goods Workstream is focused on increasing interest in digital public goods. CrossStream DAOops is focused on coordinating activity across workstreams and doing "anything that helps operationalize the DAO."

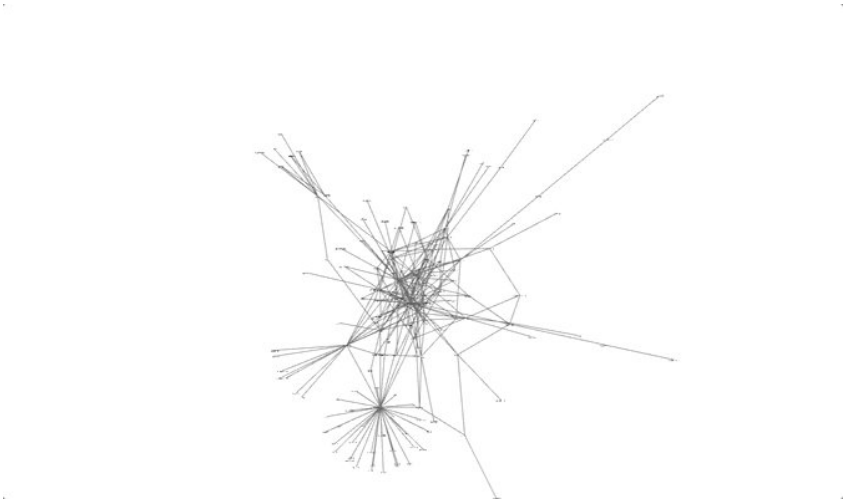
The steward council is a group made up of the most engaged stewards in the DAO. They have a mandate which includes ensuring governance proposals follow the proper template, and doing in-depth analysis of budget requests made by workstreams.

"Gitcoin" as an entity sits at the top of the hierarchy, a large system composed of many subsystems which are continually giving rise to and reformulating its structure.

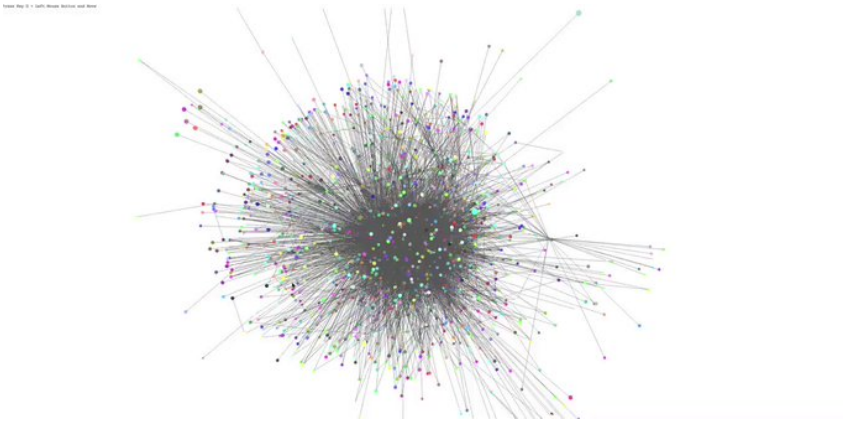
Principle 3: Systems are networks

All systems can be understood and visualized as networks. A network is collection of *nodes* which represent entities with *links* (or ”edges”) that represent flows of energy or information between the nodes.

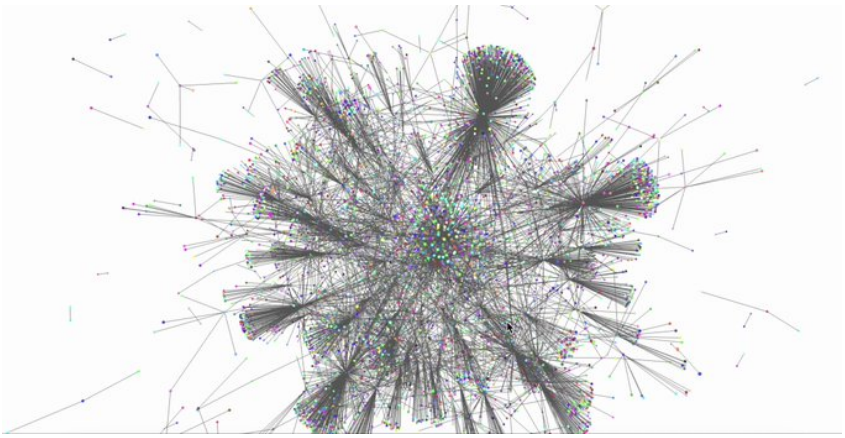
For example, this series of dynamic network visualizations of an economic graph depicts the growth of Gitcoin’s economy over time.[30] The nodes represent users and the edges represent transactions.



Gitcoin Grants Round 1



Gitcoin Grants Round 7

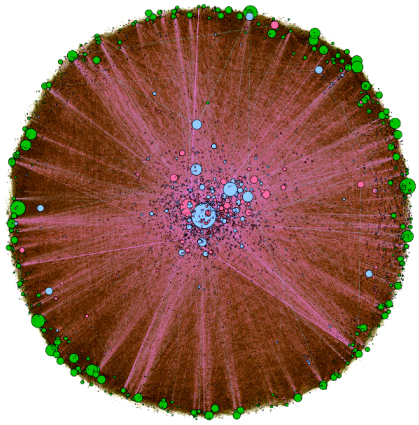


Gitcoin Grants Round 14

Network science is one of the most well developed sub-disciplines of systems science. It helps us formally understand systems by mapping their inner workings, enabling us to study properties we wouldn't be able to discern from casual observation.

Network science can be used for understanding the characteristics and behaviors of actors and groups in large complex communities. For example, when the Gitcoin team started experiencing issues with bad actors who were trying to exploit the Gitcoin grants program, they collaborated with researchers at Blockscience.[31] To identify bad actors, they first used data from Gitcoin Grants round 8 to generate a network graph that represented the interconnections between grants and donors in the Gitcoin Grants contribution network. Next, they applied a special type of community detection algorithm which returned a list of detected communities composed of grants and contributors represented as nodes, and contribution flows between them as edges. Finally, using pattern-matching, they were able to distinguish organic community behavior from the exploitive behavior of communities colluding to take advantage of the grant ecosystem.

The entire Gitcoin Grants Round 8 network, with grants denoted as blue nodes and contributors as orange nodes, and donations as the connections between them. Colored by 5 separate community subgraphs.



Contribution graph for Gitcoin Grants 10, displaying the proportion of grants to real users to sybil users. Green nodes represent grants, blue nodes represent real users, and red nodes represent sybil users.

By combining the power of algorithms along with subjective analysis by the researchers at Blockscience, Gitcoin was able to start taking actions to punish bad actors.[32] This took the form of denying donations from individual sybil attackers, deactivating accounts, removing fraudulent grants, and modification of their API to prevent further abuse. While the system isn't perfect and is constantly evolving, they are decreasing the amount of money going towards non-genuine participants. This research has been foundational in laying the groundwork for other research[33] on deterring adversarial behavior, anti-fraud evaluation, and operationalizing the Gitcoin anti-sybil process, work that has translated into new practices (such as the adoption of Gitcoin Passport)[34] which have continued enhancing Gitcoin's capacity to detect and fight sybil attacks.

Principle 4: Systems are dynamic over multiple spatial and time scales

All systems are dynamic, which means that processes change inputs into outputs over time.

At lower levels of spatial resolution, the time scales relevant to dynamics are smaller. Molecular processing occurs within micro and milliseconds, whereas the functioning of organs and organisms is measured in seconds and minutes. Meanwhile geological and geophysical changes occur over centuries and millennia. When key sub-system processes operate over sufficiently different time scales, this can lead to negative consequences and instability within the system.

The Gitcoin ecosystem must contend with variance across three different time scales:

1. Price fluctuations of the GTC governance token, which are measured in seconds
2. The budgeting process for the DAO which makes expenditures on a quarterly basis
3. Organizational plans which unfold over months and years

Crypto markets are notoriously volatile and the price of GTC has fluctuated from a high of $22/GTC in November 2021, to a low of $1.79/GTC in May 2022. In January 2022, when one GTC was worth just over $11, [35] a Gitcoin contributor pointed out that the price volatility was making it difficult to make financial and budgeting plans for the future.[36] At that time the vested treasury held $62 million worth of GTC tokens, while the operating budget had grown to $15 million/year, or 24% of the vested treasury. The rapid market dynamics that GTC is subject to operate on a completely different timescale than the long term planning required of DAO operators.

To address this dynamical mismatch, the community voted in favor of a treasury diversification plan. The DAO would sell GTC for stablecoins and hold at least one year of operating expenses in stablecoins to provide budgeting clarity and the ability to comfortably pay contributors. So far $3 million worth of GTC has been converted into the USDC stablecoin which is backed by U.S. dollars in a traditional bank account. Continued diversification into more stable assets will reduce the extent to which the dynamical mismatch between GTC token price fluctuations and organizational budgeting requirements negatively impact Gitcoin.

Principle 5: Systems exhibit various kinds and levels of complexity

All systems exhibit complexity in their structure. A system's complexity can be defined by the total number of components, the different kinds of components, and the attributes of networks within and between levels (ie.; what sort of connections exist between various parts of a system, and how many connections are there?). More total components and types of components means more complexity. Complexity can create new functionality and it can also be a source of disruption and failure. Thus, systems must find ways to manage both internal and external complexity.

The image below shows how the major scientific disciplines can be organized based on the complexity of their objects of study. Physics deals with fundamental forces and subatomic particles, systems that have much fewer components and varieties than those found in biology and the formation of societies. As the scientific disciplines increase in complexity and start contending with the actions of people, animals, and institutions, it becomes practically impossible to identify every single component within the systems and determine precise causal relationships between them.

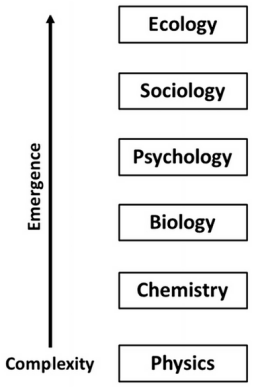


Fig. 1.1 There is a natural hierarchy of major science disciplines based on several aspects. The lower disciplines are fundamentally simpler to explore using the scientific process. Their objects of study are inherently simpler in terms of numbers of components. The emergence of greater complexity is explained in the text

Systems Science: Theory, Analysis, Modeling
(P. 46)

Gitcoin deals with increasing internal complexity such as rising numbers of contributors, grant applicants, and software products to develop and manage. It contends with rising external complexity through a growing number of competitors, outside actors colluding to game the grants program, and the rapid evolution and shifting dynamics of the crypto industry.

One major barrier that most crypto projects experience when trying to gain mainstream adoption is that users face incredible complexity in the form of needing to interact with a variety of new types of software tools that operate very differently than the ones they're used to. Gitcoin has been able to overcome this specific barrier to adoption by primarily focusing on gaining adoption from the millions of people around the world who already use crypto on a regular basis.

Complexity is such a prominent feature of systems that complexity science has emerged as a thriving discipline in its own right. However there is a key difference between the ways complexity scientists and systems scientists aim to understand complexity. Complexity scientists focus on understanding the functions that generate complexity within systems, for example by observing a flock of birds and creating computer programs (especially agent-based models) that can recreate their behavior based on simple rules. They care about how complexity emerges.

Systems science is focused on understanding how complexity manifests in systems themselves and devising quantitative measures of complexity. It prioritizes this because when we are dealing with complexity it is often more important to understand how complexity actually presents itself, not just the factors that cause it to emerge.

In order to gain a better understanding of the types of complexity that Gitcoin deals with, a "complexity dashboard" could display an array of relevant metrics. Internal complexity would be measured by compiling and aggregating existing measures (contributor count, number of grant applicants, number of core products, lines of code, number of developers, etc.) The DAO could also devise metrics to measure complexity in areas that aren't currently being tracked quantitatively. This could include quantifying the level of decentralization[37] of the system,[38] or the amount of trust[39] required for it to function. This type of dashboard would benefit the DAO by painting a clear picture of which aspects of Gitcoin are facing the most complexity. This would help engineers and project managers know where resources should be directed to help reduce or manage the complexity that the ecosystem must contend with.

Principle 6: Systems evolve

All systems are either evolving towards higher organization, maintaining their current state, or decaying towards random disorder. Systems need an abundance of incoming free energy in order to evolve towards higher organization or maintain complex order. Without sufficient energy flows, complex systems start decaying towards random disorder.

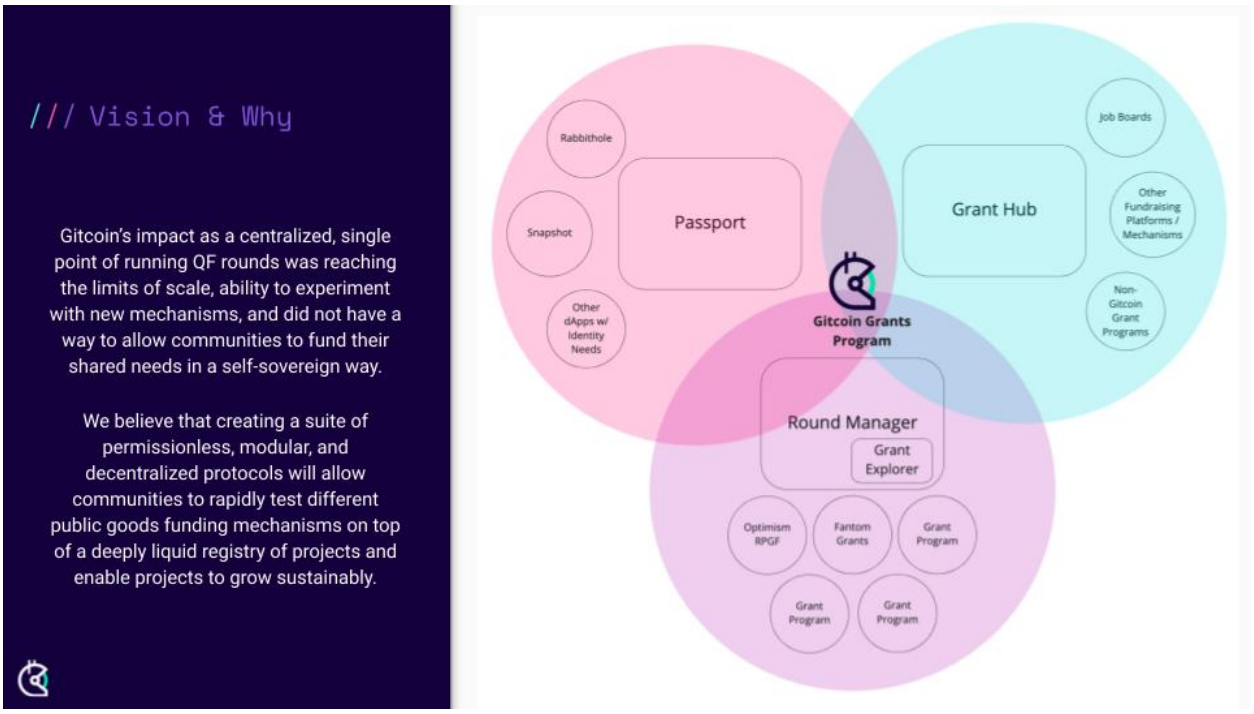
It is important to distinguish between adaptation and evolution. *Adaptive* changes involve a system changing its internal distributions of material and energy in order to account for changes in the environment. *Evolutionary* changes involve the incorporation of completely new mechanisms for obtaining and processing new material resources, performing a new function, or finding a new purpose.

Gitcoin requires energy inflows in the form of money, contributors, and ideas in order to continue achieving its purpose. It adapts in ways such as diversifying its treasury in order to accommodate changing market conditions. It has evolved from a platform focused on providing bounties to developers working on open source software, into a platform focused on using the quadratic funding mechanism to provide grants to digital public goods.[40] It went from being a minimum viable product funded by Consensys, to an independent project owned by the Gitcoin holdings corporation, to being community-owned and governed by the Gitcoin DAO and Gitcoin Foundation.[41]

Gitcoin must continue evolving in order to survive and fulfill its newly adopted and much broader purpose which is "to empower communities to fund their shared needs."[42] There are several ways in which the DAO is consciously evolving. Gitcoin is moving the grants platform away from being[43] run on a centralized platform, and towards decentralization[44] via the grants protocol.[45] Gitcoin grants is transitioning[46] from being run on a mixture of socialware (high social coordination costs) and trustware (low social coordination cost), to being run primarily run on trustware. Once this happens it will become a hyperstructure, a "crypto protocol that can run for free and forever without maintenance, interruption, or intermediaries."[47] Rather than projects and communities needing to go

through the Gitcoin organization, wait for their quarterly funding rounds, and meet criteria specified by Gitcoin, they will be able to create and manage their own funding rounds whenever they want.

The first step towards re-imagining Gitcoin as the provider of a decentralized crypto protocol rather than a centralized platform running grants rounds is focused on the development of three modular software components that will “allow communities to rapidly test different public goods funding mechanisms.”



Token Holders Update Sept 2022

The *hub* module is where project owners create their project and manage its growth over time, allowing them to build community, recruit talent, and report progress over time. The *round manager* module enables communities to run their own programs and customize the process of project selection, fund allocation, and fund management. The *passport module* enables individuals to collect verifiable credentials that can be used across different platforms, and enables builders to secure their platforms with open scoring models.[48]

The development and release of these three free, open-source modules will help Gitcoin scale impact by empowering communities to self-run grounds and configure round structure to meet their needs. The grants protocol will be a digital public good that facilitates the rapid growth of projects that want to use it for funding any type of public good, digital or physical.

Systems evolve in certain directions because of selective pressures. One selective pressure shaping Gitcoin’s evolution is an increasingly crowded market for crypto-based grants programs and public goods funding.[49] While the DAO has a larger amount of financial resources at its disposal than its

competitors, this hasn't always translated into better performance and efficient product development. The DAO must improve in this area in order to maintain its position as a leader in this space.

Gitcoin also must develop a model for financial sustainability, it needs adequate flows of money (a form of stored energy) to continue evolving towards higher forms of organization. The DAO currently does not have a stable source of revenue.[50] This has led to high quality stewards stepping back because of inadequate compensation. One steward said, "At this point I would like to remain a steward but step down from the council as it's demanding time-wise, compensation is not enough."[51]

From 2017 to present, Gitcoin has evolved and progressively decentralized from being a centralized solution for funding open source within the Ethereum ecosystem, to being a decentralized leading voice at the center of a broad ecosystem of "ImpactDAOs" focused on using crypto to create positive externalities for the world.[52]

Principle 7: Systems encode knowledge and send and receive information

All systems send and receive information which is stored and encoded as knowledge. *Information* can be understood as a measure of uncertainty which is reduced when a system receives a message from a sender. This reduction in uncertainty causes a structural change in the receiver which is proportional to the amount of information encoded in the message. The structural change in the receiver minimizes the amount of surprise experienced by the system when it receives similar messages in the future. Whether or not something is understood as information depends upon the properties of the receiver, not the intent of the sender.

Knowledge is the ensuing structural changes in the receiving system which modify the channels of information through which energy flows. Knowledge of how a system should act is encoded in its structure and is constantly updated by novel information. Changing knowledge means changing organization, and the current configuration of a system determines its future possibilities.

Kevin Owocki is the founder of Gitcoin. Since he has been involved with the project since the very beginning, he has a large amount of knowledge about the project. As he has stepped away from leadership[53]in the DAO in order to allow new leadership to emerge and encourage decentralization of power, he has started creating a series of "knowledge transfer"[54] posts on the governance forums.

For example, in a knowledge transfer post about generating economic graph visualizations,[29] Kevin shared a message about the process he uses for generating the network visualizations of Gitcoin's economy mentioned in the section about networks. Since he is stepping down from a formal role with Gitcoin, he'll no longer be creating them. Gitcoin and its members did not know how to create these networks before Kevin made the post, so Kevin's message contained new information which has been incorporated as knowledge in the form of a post that lives on the Gitcoin governance forums. If Kevin were to send the same message at some point in the future, it would no longer be information for the DAO, or at least not for any members that had already seen the message.

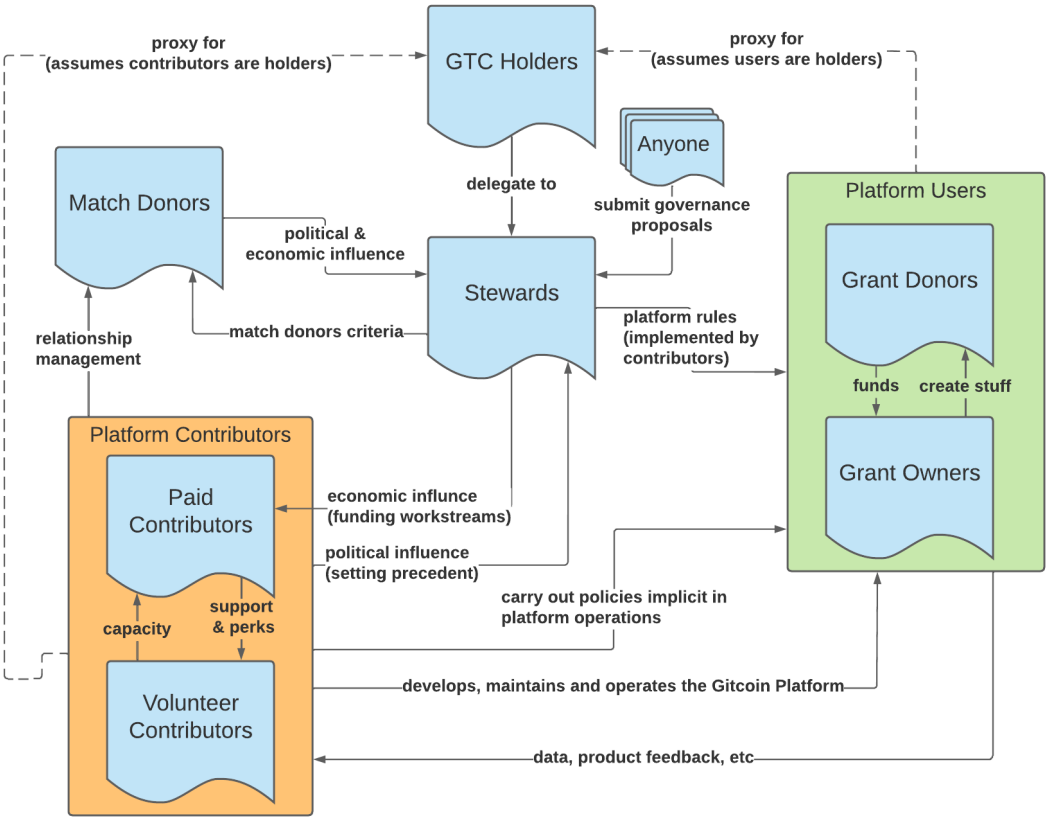
Principle 8: Systems have governance subsystems to achieve stability

All systems use governance (or regulation) subsystems in order to achieve stability. Stability means maintaining system integrity and function over time. These subsystems achieve stability through feedback processes that monitor and correct a given system's course of action. When something unexpected occurs, the subsystems alert the main system and help coordinate activity between the components.

For Gitcoin, stability means sufficient revenue to compensate stewards and contributors, donations for grant recipients, lack of dependency on centralized services to ensure uptime, and an organizational capacity to build new high quality software.

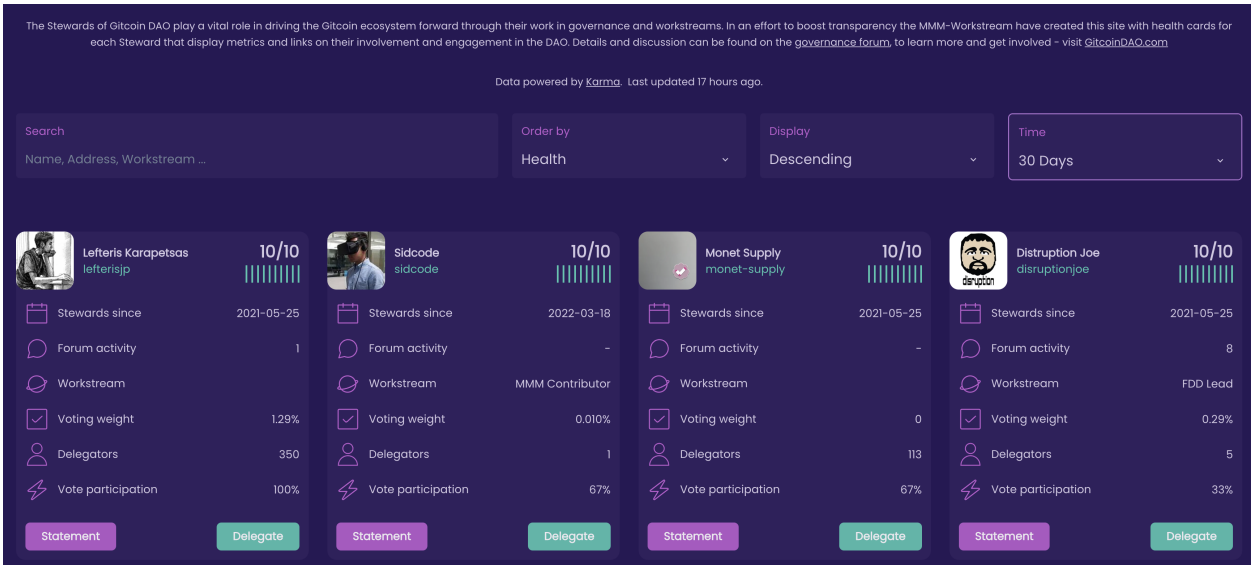
Gitcoin's key governance subsystems include workstreams, the steward council, and Cross stream DAO Operations.[28] Meanwhile, the GTC token subsystem is used to coordinate governance decisions. The Gitcoin forums and Discord server are online channels where discussion about governance takes place.

The following diagram shows the relationships between the key stakeholder groups within the Gitcoin ecosystem and helps to illustrate how power is distributed within the DAO. Understanding this structure is key for anyone that wants to effectively participate in the system's governance.[28]



Ecosystem Mapping & Discussion

One example of a governance feedback mechanism is the steward report card system.[55] Stewards, as mentioned earlier, are individuals who GTC holders have decided to delegate their tokens to, enabling the steward to vote on behalf of the delegator. Key information about all stewards is displayed on a dashboard. This information includes how active they are on the forums, how much GTC has been delegated to them, and their voting participation rate. If a steward is underperforming then everyone can see it, delegators can choose to delegate their GTC to a different steward and the steward council can hold discussions about what to do about underperforming members.



There is a formal governance process for making key structural changes to the DAO or moving GTC from the DAO treasury. First, a contributor posts their proposal on the forums, using the Gitcoin Community proposal template, so the community can review and comment.[56] They provide a link to a snapshot vote, an off-chain (non-binding) process that allows for a temperature check on the idea. The proposal must be available for review for five days and receive input from at least five stewards before moving to a formal vote.

After the discussion period is over, a formal on-chain vote can take place using a system called Tally.[57] The voting power of each member is directly proportional to the amount of GTC they hold, and a simple majority of GTC in favor of a proposal is all that's required for it to pass. A quorum of 2.5 million total GTC participating is required for any proposal to succeed.

There is a lot of work to be done in improving the efficacy of DAO governance before there is any hope of them replacing traditional forms of organizations at scale. Gitcoin steward Simona Pop reflects that "evolving DAOs feels like building a house on quicksand. During an earthquake. In the rain."[58] She emphasizes that in order to successfully support the flourishing of this new form of organization, DAOs must develop clear *standards*; hold space for safe, considerate, and constructive *engagement*; find *equilibrium* by avoiding extremes and rejecting binary choices; and create an environment where people are incentivized to take *responsibility* and are rewarded for doing so.

Principle 9: Systems contain models of other systems

All systems encode models of (or at least aspects of) the environment they interact with. Models are simplified versions of reality designed to address specific questions. Systems use partial models of other systems as guides that specify what is important in their interactions with them. The main objective for any model is to help the system achieve its goals through a better understanding of its environment. Models must adapt to changing conditions or they will become dysfunctional. Over-reliance on any particular model will produce unexpected problematic side effects.

A simple example of a model is a puzzle piece that has the edges of the other pieces built in, it anticipates them and has expectations on how they will interact. Humans have many more complex models in their brains that guide how they perceive and interact with the outside world. For instance a child holds certain mental representations of their parents which influences their behavior around them.

Gitcoin needs to have a model of what sybil attackers look like in order to defend against efforts by sybill attackers to game the grants system. If computational analysis shows that a group of accounts exhibit behavior that correlates with fraudulent activity, then humans should investigate further. Feedback from humans about which groups were actually engaged in collusion is fed back into the model which is continuously updated.

Gitcoin needs models of markets to anticipate their behavior and make necessary adjustments to the system.[59] For instance, the behavior of donors is different in a bull market when people feel wealthy than it is in a bear market when people feel poor.

Principle 10: Systems build internal models of themselves

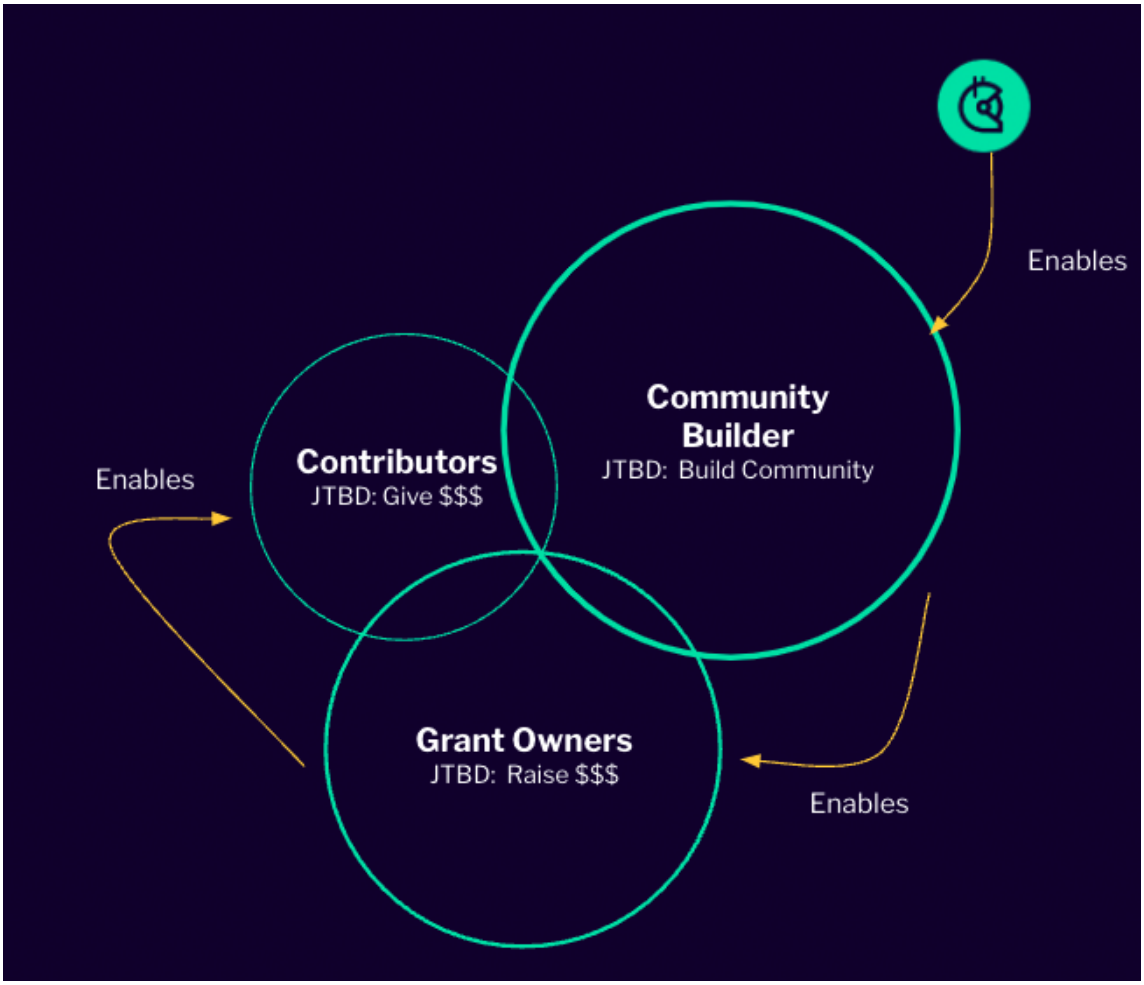
Any sufficiently complex system will contain a model of itself, an internal representation of what and where it is that informs and guides its activity. The brain develops a sense of self known as identity, an ant colony generates a sense of the needs and wants of the colony and reacts accordingly. Self-models are protocols for inner organization and interaction with the environment. Self-models provide continuity and identity but can also act as barriers to change. Adaptive systems will continually modify their internal models to increase accuracy and account for changes.

Systems made of multiple layers of systems have complex dynamics. The self-models of each component system are constantly shaping each other. Understanding the layers and interactions of self-models helps with the identification of ideal points for strategic intervention and leverage in complex systems where users are both components of the system and individual agents with autonomy and some capacity to effect change.

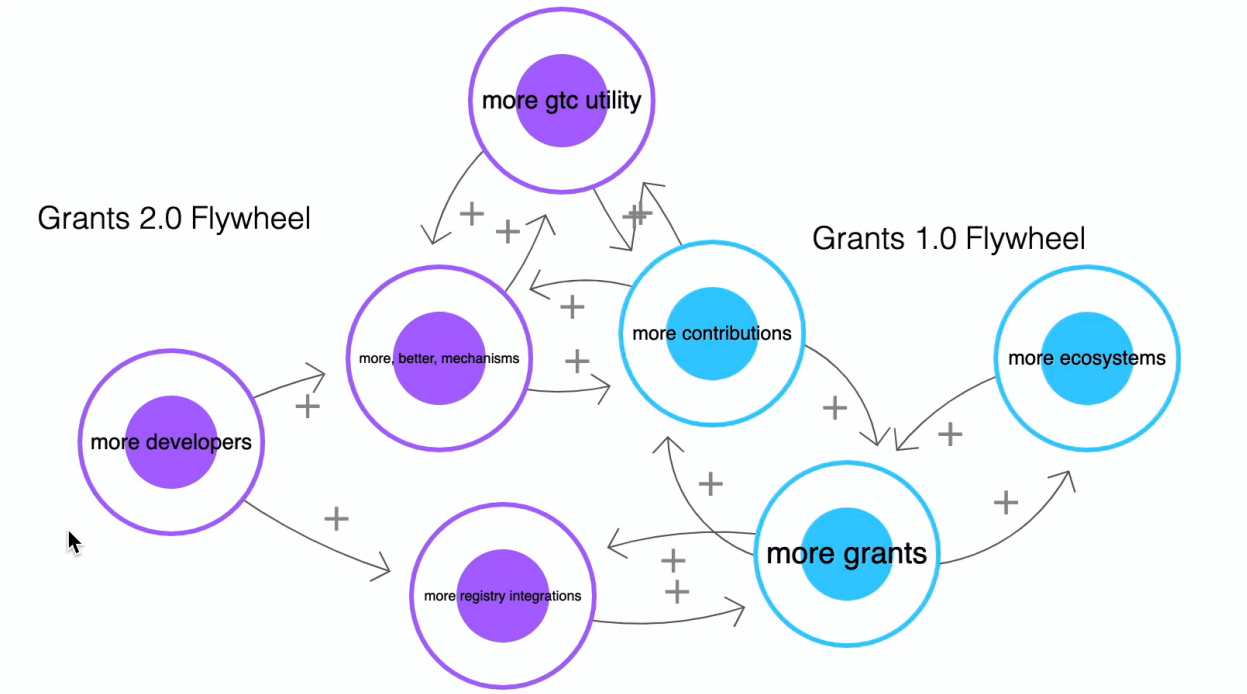
Gitcoin has source code, a self-model encoded in software that both describes and determines much of the system's behavior. Source code functions like DNA in that it contains the knowledge necessary to replicate a system.[60] Gitcoin's source code helps determine how the organization interacts with humans and other software systems. It is both a source of stable identity, and something that is subject to continual change and upgrades as Gitcoin adapts and evolves to better achieve its purpose.

Technical, formal self-models interact with fuzzy mental models that exist in the human brain. One self-model, a way of thinking about Gitcoin, is of Gitcoin grants as a triple sided marketplace.[61] Gitcoin empowers community and ecosystem builders. This is accomplished by empowering grant

owners to raise money, which is accomplished by empowering contributors to find and support good projects.



It is a “virtuous flywheel” where each side of the market contributes to the network effect of the entire market. The Grants 2.0 protocol will enhance the centralized Grants 1.0 flywheel by giving ecosystem partners more and better mechanisms, registry integrations, and governance utility.



The Grants 2.0 Flywheel

Looking at the flywheel model can help guide strategic decision making and changes in software-based models. For example, as Gitcoin looks for ways to increase utility of the GTC token, it is clear that focusing on increasing the quantity and quality of available mechanisms can help achieve this goal. One recently introduced concept is GTC "staking," a mechanism that helps users verify their own identity or authenticate the identity of someone else in a decentralized manner by temporarily locking up their GTC tokens in a smart contract using the passport module.[62]

Principle 11: Systems can be understood

All systems can be understood using science. *Understanding* refers to our capacity for using mental models that correlate with relevant features of systems in the world in order to achieve our goals. When you understand a system you can make predictions, or testable scenario projections, that allow you to assess the model's explanatory power.

Effective models lead to greater understanding, but understanding is never complete. Models must be continually updated as feedback from real world experience produces new alternative models and perspectives.

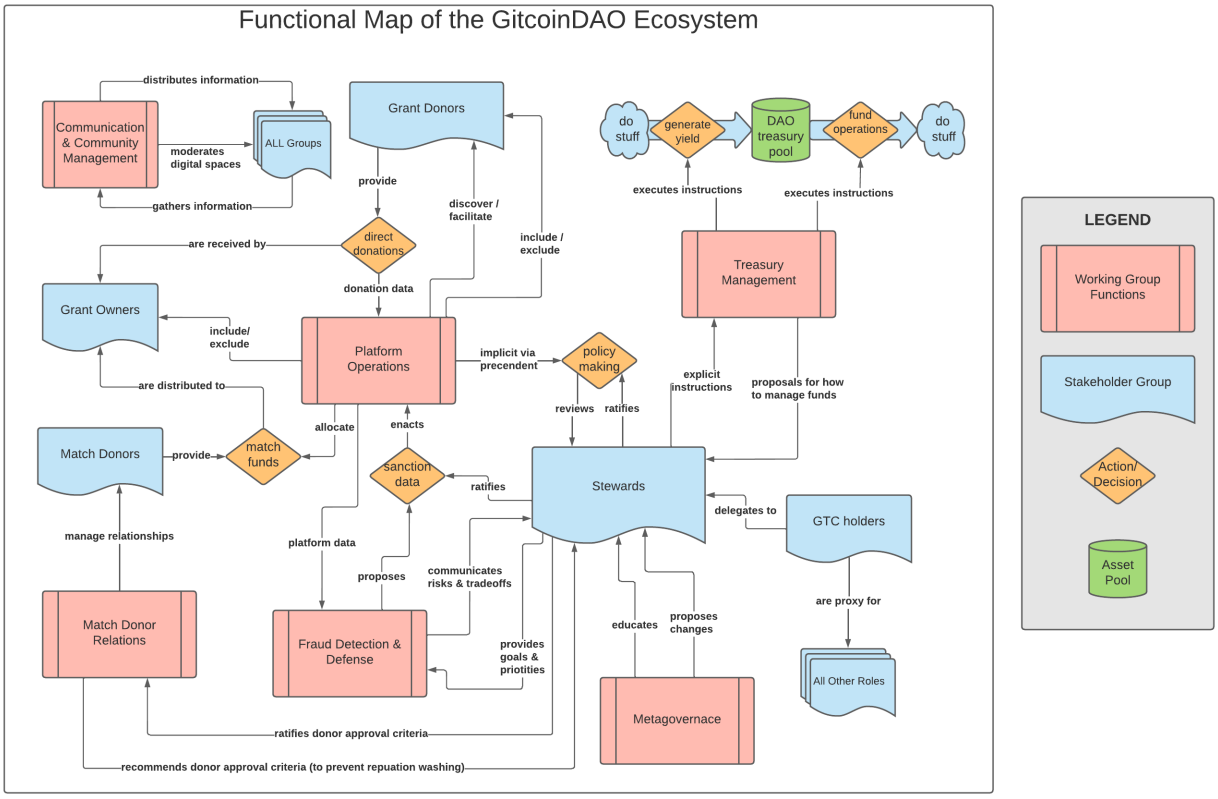
There are several ways that Gitcoin contributors understand Gitcoin as a system. These include data reports, written reviews, and academic research papers.

Data driven reports and dashboards play a major role in helping the Gitcoin community achieve self-understanding. The GitcoinDAO Governance & Financial Overview dashboard displays a variety of charts and metrics with key information about the DAO that is automatically updated by pulling data

from the blockchain.[63] The total numbers of GTC holders and delegators, distribution of the GTC token, and information about workstream spending are just a view of the indicators which help paint a clear picture of the current state of the DAO. Grants round dashboards provide detailed information about participation in individual grant rounds such as how much was donated each hour.[64] Monthly financial reports provide users with "a detailed understanding of treasury health, monthly spending and emissions of GTC."[65]

Written reviews provide qualitative subjective analysis to compliment quantitative information found in the data. Gitcoin "Year in Review" posts,[66] Vitalik Buterin's grants reviews,[67] and Token Holders Updates provide valuable context and information from experts and leaders within the community.[47]

Systems mapping can play an important role in helping stakeholders and researchers develop an understanding of a system. The following functional map diagram illustrates the various operational functions which need to happen for Gitcoin to continually achieve its purpose. [28]



Ecosystem Mapping & Discussion

A number of academic research papers have been published focused on gaining a deeper understanding of Gitcoin. One researcher used quantitative methods to conclude that "because of its quadratic design, matching funds requirements scale rapidly, particularly by more numerous and equally contributed projects."[68] Another researcher performed a case study concluding that "in its

historical context, Gitcoin has been a success in outperforming prior attempts at providing a shared funding tool for the Ethereum community."[69]

Principle 12: Systems can be improved

All systems can be improved via engineering. The notion of improvement is only relevant when the operation of a system is observed to be aiming at a certain result. System function can only be improved once a consensus is formed as to what the goals of the system are. These conversations can be confounded by issues of competing interests, priorities, and definitions of system boundaries.

In complex systems improvements to specific functions always have side effects which may or may not be beneficial for the system as a whole. It is easier to improve the functioning of individual agents than it is to improve the overall functioning of complex multi-agent ecosystems. One person's sensed improvement will always be problematic from opposing perspectives. At a systemic level, it is important to balance the needs of the individual components with the needs of the system as a whole.

In May 2022 a member of Gitcoin's DAOops working group made a post noting that community members had raised concerns about "growing misalignment between GitcoinDAO contributors, stewards, community, and fans around the DAO's mission and methods for delivering outcomes on that mission."[70] The misalignment was a result of the fact that Gitcoin's stated mission has evolved over time, and the DAO is experiencing the the expected growing pains of a new organization, not to mention one that is experimenting with cutting edge technologies. This confusion led to serious issues for Gitcoin, with contributors expressing concerns about the budgeting process and expenditures that seemed "out of sync with the stated mission and vision of Gitcoin Holdings."

To address these concerns, a process of consensus formation via a strategy session was launched in which workstream leads met to develop a "shared sense of potential statements of DAO-level Purpose and Essential Intent." Attendees drafted and voted on potential purpose and essential intent statements, and eventually elected a subgroup to synthesize discoveries from the session into draft language for consideration by the broader community.

This process forced the organization to have tough conversations around competing interests, priorities, and defining system boundaries. One contributor expressed concerns that improving Gitcoin's ability to support a broad range of communities by adopting the purpose "to empower communities to build and fund their shared needs" would make the system vulnerable to "being used to raise funds for nefarious purposes or even just things that aren't public goods." Owocki countered by expressing his perspective that it would be healthy to "defer to communities to define their own shared needs" because, "the moral content for each community is relative to their own value systems (and should not be imposed by us or anyone else, it should be sovereign to those communities)." There was an apparent tradeoff between improving a specific function (empowering communities without imposing external values on them) and improving the whole of Gitcoin by

ensuring that the project maintained strong and specific core principles to glue the community together.

In mid-June a newly adopted purpose and essential intents statement was ratified.[41] The statement reflected the current state of Gitcoin and how its goals, methods, and priorities have changed over the years. The resulting clarity from these discussions has improved Gitcoin's capacity to achieve its purpose, by creating internal alignment around a concrete set of priorities for the organization.

Conclusion

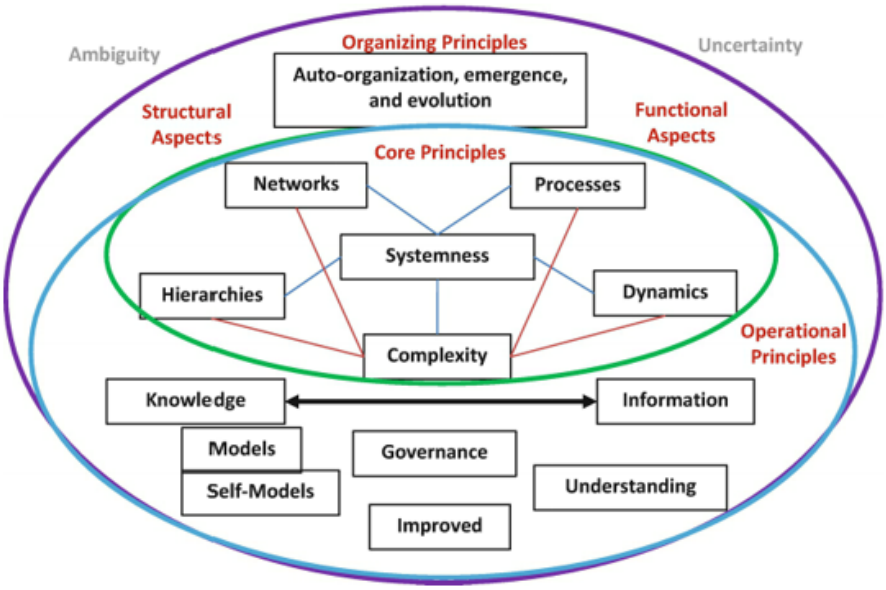


Fig. 2.5 A system of system science principles

A diagrammatic representation of the twelve principles. *Systems Science: Theory, Analysis, Modeling, and Design P.124* (*Mobus, 2022)*

This piece has sought to demonstrate the value of using systems science as a framework for gaining a deeper understanding of complex systems. We've examined ways in which formal methods of systems science have helped Gitcoin solve specific issues. We've also shown how looking at the organization through the lens of systems science principles can help us gain a comprehensive understanding of the system's past and current state, and a sense for what sort of changes might help it thrive in the future.

Future systems science inspired research on Gitcoin could include the use of well-developed methods (agent-based modeling, network science, system dynamics modeling) as well as the novel methodology for deep systems analysis proposed in Mobus' latest textbook. As the DAO navigates the complex and messy transition from manager of a centralized platform to steward of a

decentralized protocol, a rigorous systems perspective will be essential if it is to remain a reliable pillar of support for digital public goods projects.[71]

Many of the existential threats facing humanity, from insufficient support of public goods, to the resurgent threat of global nuclear war, stem from a lack of deep understanding about the complex systems we create and are embedded within. We don't understand the variety of causal mechanisms that lead to problems and how they all relate to each other. Traditional academic disciplines, existing in silos of specialized knowledge and terminology that is impenetrable to outsiders, are poorly equipped to deal with the inherently inter-disciplinary problems of our time. A well-developed science of systems promises to provide us with a robust general framework for understanding the features and dynamics of the systems we are constantly participating in. It can give us a universal "language of systems" that allows specialists from different disciplines to easily communicate about complex problems. It can help us with improved navigation, capacity for anticipating issues, and ability to leverage systems in a manner that is sustainable and regenerative for ourselves and the environment.

The principles outlined in this paper can be applied to any system in the universe and therefore can serve as a solid theoretical foundation for developing such a science of systems, a science that is desperately needed to achieve continued and more broadly shared prosperity for the human race.

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