

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/319529311>

Experiments in Algorithmic Governance: A history and ethnography of " The DAO, " a failed Decentralized Autonomous Organization

Chapter · January 2017

CITATIONS

134

READS

7,125

1 author:



[Quinn Dupont](#)

University College Dublin

22 PUBLICATIONS 262 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Critical Cultural Studies [View project](#)



Human and Social Dimensions of Code and Cybersecurity [View project](#)

Chapter 8

Experiments in Algorithmic Governance: A history and ethnography of “The DAO,” a failed Decentralized Autonomous Organization

Quinn DuPont
University of Toronto

This chapter describes an emerging form of algorithmic governance, using the case study of “The DAO,” a short-lived attempt to create a decentralized autonomous organization on the Ethereum blockchain platform. In June, 2016, The DAO launched and raised an unprecedented \$250m USD in investment. Within days of its launch, however, The DAO was exploited and drained of nearly 3.7m Ethereum tokens.

This study traces the rise and fall of this emerging technology, and details the governance structures that were promised and hoped for, and those that were actually observed in its discourses. Through 2016-2017, these discourses were collected from online discussions and subsequently analysed. Using computer-assisted, qualitative analysis and coding, I traced the discursive strategies of the developers and the community of investors, identifying: 1) questions of legal authority, 2) tensions in practical governance, and 3) admissions of the inherent complexity of bringing to life an algorithmic and experimental organizational model.

This chapter describes a short-lived experiment in organizational governance that attempted to utilize algorithmic authority through cryptocurrency and blockchain technologies to create a social and political world quite unlike anything we have seen before. According to the visionaries behind the project, by encoding the rules of governance for organizations and governments in a set of “smart contracts” running on an immutable, decentralized, and potentially unstoppable and public blockchain, new forms of social interactions and order would emerge. This experiment was an example of a new form of organization, called a “Decentralized Autonomous Organization,” or DAO. The forms of sociality that would

emerge—they promised—would be transparent, efficient, fair, and democratic.

While the idea of decentralized autonomous organizations had been mooted since the early days of cryptocurrencies, the launch of sophisticated blockchain platforms with built-in programming interfaces gave enthusiasts a practical, technical apparatus to realize their vision. Foremost among these emerging blockchain platforms was Ethereum, a so-called distributed “Turing-complete” computer. The Ethereum platform is new and expanded version of the Bitcoin system in that it adds a layer of software on top of a blockchain. Like Bitcoin, Ethereum is

also comprised of decentralized “mining” computers, but whereas the Bitcoin miners primarily authenticate transactions, the Ethereum miners authenticate and run executable code.

It seemed like decentralized autonomous organizations would finally get their day in 2016, when a design built on the Ethereum platform emerged from a small blockchain company called Slock.it. Earlier, in June 2015, Slock.it begun development of a decentralized autonomous organization framework, accepting contributions from the open source software community. By March 2016, a large community had begun to form around the open source framework, and Christoph Jentzsch of Slock.it published the corresponding whitepaper on March 15, 2016 (Jentzsch, 2016). The community formed through the Slack messaging service initially, and then launched an online forum independent of Slock.it, calling themselves DAOhub, which was co-founded by Felix Albert and Aurnyn Macmillan, and joined by a core team of six other members. Slock.it was sympathetic and encouraging of the DAOhub, and wanted their design to become a “standard” for future decentralized autonomous organizations to build on. In April 2016, the DAOhub community appointed 12 “curators,” backing the project with the imprimatur of industry heavyweights, including Vitalik Buterin himself, the wunderkind and inventor behind Ethereum.

The very model of simplicity, a mere 900 or so lines of software source code, this design was given the placeholder name of “The DAO.” The DAO was intended to allow cryptocurrency “investors” to directly fund and manage new enterprises—all to be run on the Ethereum blockchain. Because The DAO was backed by Ethereum, complex business logic could be programmed, and once set in action, the organization would be virtually unstoppable. The blockchain would ensure that all business transactions and organizational changes would be immutably recorded on a public ledger authenticated and controlled by a large, decentralized network of computers. Moreover, because the organizations spawned by The DAO were directly funded through digital token-holding “investors,” each organization

would be, in-effect, directly managed by its investors, as per the investment stake of the individual (i.e., those investors who contributed more tokens would get a correspondingly larger number of votes on organizational decisions). No need for messy and inefficient human negotiation—so it seemed!

The DAO was launched on April 30, 2016, at 10:00am GMT/UTC (by several “anonymous” submissions associated with DAOhub, who executed the open source bytecode on the Ethereum blockchain), with a set funding or “creation” period of 28 days (A2be, 2016). As the funding period came to a close (concluding May 28, 2016), The DAO went live with the equivalent of about \$250m USD in funding, breaking all existing crowdfunding records. Some 10,000 to 20,000 (estimated) people invested in The DAO, contributing 11,994,260.98 Ethereum tokens (known as ether, or ETH), which amounted to about 14% of the total ETH supply.¹ However, shortly after the minimum two week “debating” period, on June 17, 2016, The DAO’s code was “exploited” by an unknown individual. This exploit used unintended behaviour of the code’s logic to rapidly drain the fund of millions of dollars’ worth of ETH tokens. Immediately, Slock.it, the leaders of the Ethereum platform, numerous cryptocurrency exchanges, and other informal technical leaders stepped in to stem the bleeding—shutting down “exits” through the exchanges, and launching counter-attacks. It is at precisely this point that we see the vision of future governance structures break down, and devolve into traditional models of sociality—using existing strong ties to negotiate and influence, argue and disagree—all with nary a line of code in sight. In the end, the whole project was disbanded, with an inglorious “hard fork” rolling back the ostensibly “immutable” ledger.

This chapter details the governance structures that were promised by the developers and community members involved in the making of The DAO, and in contrast, those that were observed in its discourses before, during, and after the “exploit.” With the term “governance,” I intend a broad scope: governance is the “conduct of conduct” through the plurality of (human and non-human) actors that are interdependent but lack the power or authority to

decide and enact solutions unilaterally and directly (Introna, 2016: 19), which enables a broad set of “governance options” as risks and solutions (Saurwein et al., 2015). In analysing “discourses,” I mean the “cohesive ensemble of ideas, concepts, and categorizations about a specific object that frame that object in a certain way and, therefore, delimit the possibilities for action in relation to it” (Epstein, 2005: 2). The discourses surrounding The DAO reflect governance through its technical makeup, as a deeply embedded socio-technical apparatus that permits, prohibits, enables, disables, promotes, and limits courses of action.

My goal in this chapter is not to discredit the idea of decentralized autonomous organizations, but rather to highlight some of the ways that such discourses and their operationalization do and do not (currently) work. Thus, “true believers” in the technology will see that the world is simply not yet ready for decentralized autonomous organizations, or that Slock.it and the DAOhub’s version was flawed (such criticisms were widespread well before its launch). Critics of The DAO’s utopia, on the other hand, will realize that human sociality crops up whenever humans are involved, and that existing governance structures are in fact well refined through thousands of years of social commerce, government, and exchange—not the idealistic, pre-social vision that arguably never existed. Either way, The DAO introduced and explored an interesting technology for experimenting with governance issues and new models of society.

VISIONS OF DECENTRALIZED AUTONOMOUS ORGANIZATIONS

The DAO was a decentralized, crowdfunded, direct-management (or direct-democracy) organization and investment platform. The DAO was the first high-profile realization of a Decentralized Autonomous Organization (DAO) running on the Ethereum platform (other DAOs exist, and existed).ⁱⁱ Whereas The DAO had visions of being the DAO to end all DAOs, most DAOs differentiate from one another by offering slightly different functionality, market verticals, and governance structures.

In the original vision of decentralized autonomous organizations, as proposed by Vitalik Buterin, founder and member of the Ethereum Foundation, a DAO is a pseudo-legal organization run by an assemblage of human and “robot” participants. The robotic participants are algorithmic rules that run on the distributed Ethereum blockchain, and automatically respond to inputs according to programmed rules. Inputs can be varied in type, including fully autonomous sensors (e.g., a digital thermometer), online inputs (e.g., a change in stock price), or “real-world,” external decisions by human agents.ⁱⁱⁱ Based on these inputs and the pre-programmed logic stored on a distributed blockchain, the idea is that a DAO would automatically initiate action in an irreversible way (all changes would be written into an immutable distributed ledger). Potential actions a DAO might take include distributing cryptocurrency (such as ETH, for “fuel” or payment), or making a computation and issuing an output, such as triggering software or electromechanical (or IoT) devices.

From the inception of Ethereum and its much lauded decentralized autonomous organization concept there had been very little concrete development of DAOs until The DAO was launched. The DAO was an attempt to build a funding platform, similar to Kickstarter, but one that specifically used decentralized autonomous organization (blockchain) technologies for its operation. Whereas Kickstarter raises funds from many individuals through their centralized administration, typically for the development of commercial products (often “rewarding” the funders through a pre-sale mechanism), The DAO sought to raise funds direct from peers (decentralized, peer-to-peer crowdfunding). This “funding” mechanism remains a contentious, poorly-understood, and increasingly prevalent practice. Later, in conversation with Christoph Jentzsch, he described his vision of The DAO’s economics as a very large joint bank account, not a “sale,” or “security.” Following The DAO, through 2016-2017, numerous “initial coin offerings” would be launched that continued to skate on legal thin ice with respect to securities and finance law, raising impressive amounts of investment from unvetted and typically amateur investors.

DuPont, Quinn. Experiments in Algorithmic Governance: A history and ethnography of “The DAO,” a failed Decentralized Autonomous Organization.” (ed. Malcolm Campbell-Verduyn) *Bitcoin and Beyond: Cryptocurrencies, Blockchains and Global Governance* (forthcoming).

To raise funds for a pool of investment (controlled by The DAO token holders), the first stage of The DAO was a funding period or “creation phase” of 28 days (beginning April 30 and concluding May 28, 2016), during which time anyone could exchange ETH cryptocurrency for DAO tokens in return. During the initial funding period the price of DAO tokens rose programmatically (from an initial value of 1:100)—encouraging early buy-in (a masterful sales tactic, encouraging people to “act soon, limited supplies!”); formally, the price increase was to reward the riskier (information-deficient) behavior of early investors. After the initial funding period, no more tokens would be created; however, it would be possible to trade existing tokens on public cryptocurrency exchanges.

Tokens would be used to directly fund and control “proposals” on The DAO platform. Anyone with a (refundable) minimum token deposit could create a proposal to be voted on by token holders. Investors voted by allocating DAO tokens for specific proposals.^{iv} Since tokens would be valuable (comprised of exchange-convertible ETH cryptocurrency), “voting” for a proposal was conceptually the same as funding it, in much the same way that projects are funded on Kickstarter. Unlike Kickstarter, however, DAO voting members would have significant control over projects. Since proposals were expected to be as transparent as possible (ideally, with their operational logic programmed into the blockchain), DAO voting members would directly control an organization by voting for (i.e., funding) specific decisions. For example, voting members could decide—directly—if a new employee was hired or not by using their votes to approve or deny the decision (or even, in fact, use their tokens to directly pay the employee). The level of management granularity would be set by the decentralized autonomous organization contract that runs on the blockchain, and projects could choose to have the minutia of decisions voted on by members, or decide to have only major decisions go to vote. Those members holding the most tokens—majority stakeholders—would have greater influence over decisions.^v

The DAO proposals

On May 28th, The DAO officially went “live” after an initial 28 day funding period. During this “creation phase” the community of investors discussed “proposals” for how The DAO funds might be used. The proposal with clearly the most community support was Slock.it’s own: use The DAO funds to hire Slock.it to design and manufacture a “smart” lock system that would enable “sharing economy” members (such as AirBnB homeowners) to programmatically grant access to their homes to approved renters. Since The DAO was intended to fund the development of this smart lock system, to be built by Slock.it, The DAO token-holders would earn rent on each transaction that used the system. The proposal was enticing to many investors because it used many aspects of blockchain technology to accomplish its primary function, such as, payment and granular management of access that would function through smart contracts on the blockchain, in an open, immutable, and verifiable manner. That rent was being extracted on each use did not seem to bother many people interested in the idea of a “sharing” economy. That Slock.it developed a funding platform for the primary purpose of enticing investors to fund their own enterprise *was*, however, a concern for many in the community. Early on, foreseeing future problems, commentators on The DAO worried about potential conflicts of interest between Slock.it’s development and control of The DAO and Slock.it’s status as potential hired contractor.

Although vastly less popular than Slock.it’s proposal, a few other ideas for The DAO emerged, including one by a French company hoping to create a ride-sharing vehicle (Mobotiq), and a proposal for an online gaming system (Firstblood). Given my own interest in understanding the dynamics of distributed funding and governance platforms, I also begun the process of setting up an organization that would use The DAO. My hope was that in creating an environmental charity using The DAO, along with fellow researchers (at University College Dublin and the University of California, Irvine), we would be able to study real-world activities through

participant observation. By participating in and observing The DAO community and its technology, we hoped to see how these new forms of economics and management were being used. Unfortunately, none of these ideas made it to the formal proposal stage prior to the exploit.

The DAO of whales

The research groups that had loosely formed to study The DAO had been collectively studying cryptocurrencies and blockchain technologies since the early days of Bitcoin. We had observed many early cryptocurrency challenges, such as when the then-leading Mt GOX cryptocurrency exchange was hacked, Bitcoin went through violent price swings, and Silk Road facilitated the sale of drugs and guns online. We also observed how cryptocurrencies were transitioning away from cipherpunk ideologies, and away from use as an online replacement for cash. Principally, I wondered if the emerging venture capital backed blockchain companies would lead to a new era of respectability or legitimacy for cryptocurrencies. At the time, it seemed like The DAO was clearly a part of this trend of cryptocurrencies moving towards dominant capital (cf. Bichler and Nitzan, 2004), and I hoped that by studying the formation and operation of The DAO, from the inside, we would see how such systems might facilitate new forms of democratic control and enable massively-crowdfunded financing.

The environmental charity I proposed was called “The DAO of Whales.” Running on The DAO platform, the charity sought to directly and *autonomously* care for a pod of orca whales in the Pacific Northwest. The entire charity would run in a transparent fashion on the blockchain, and through a series of smart contracts, its primary function would be to disburse funds to a scientific research group studying our “adopted” pod of orcas (the choice of research group to receive the funds would also be decided through the voting mechanisms supplied by The DAO). Using techniques made possible by blockchain technologies, the payments from the charity would be automated, verifiable, and censorship-resistant (or “unstoppable,” in the sense that the system would need to be changed or eliminated).

I believed that charity organizations, in particular, would benefit from these kinds of capabilities, since charities are sometimes accused of financial mismanagement and opaque governance.

Additionally, to see how far I could push the idealistic vision of decentralized autonomous organizations, I proposed reviving the concept of a deodand to create a human-whale-robot hybrid organization. A deodand is a medieval idea that imbued all created things with legal status, which therefore would give rights and duties to all things, just like human law (the concept of the deodand has in the past led to legal cases where farm animals have had to stand trial for their crimes—which, humorously, included being dressed in appropriate clothing and sitting in the witness stand). For my human-whale-robot hybrid, The DAO would legitimize the identity of the hybrid by realizing its programmatic operation and economic performance, in effect, creating a new kind of legal entity.^{vi}

Why whales? I was inspired by a science-fiction idea mooted in the Ethereum community (Schroeder, 2014), which imagined that a DAO might work as a kind of legal counsel on behalf of a pod of whales. So, for example, to ensure their own safety, The DAO could automatically (and irrevocably) disburse funds if certain programmed criteria were met, such as if an oil spill occurred in the region. In this way, The DAO (on behalf of the whales) would automatically hold humans financially responsible for their actions, and redress any negative events by funding appropriate countermeasures (such as paying for oil cleanup). As the original author of the idea stated, “This is not ‘save the whales,’ it’s ‘give the whales the tools to save themselves’” (Schroeder, 2014).

The Exploit

In the months leading up to the post-funding, launch date of The DAO, numerous community members expressed worry about the security and governance of The DAO. One community member called it an “experiment in responsibility,” and, in general, it was becoming clear that Slock.it might not be the safe shepherd the community had hoped

for (Ryan, 2016). The most pressing and vocal critique came from cryptocurrency researchers Dino Mark, Vlad Zamfir, and Emin Gün Sirer, who released a whitepaper on May 26, 2016 (when The DAO was launched but in the static “funding” period), outlining eight possible security risks (Mark et al., 2016). Although these security risks were based on game theory issues, rather than actual code bugs, given the status of these researchers in the field, and the unexpected success of The DAO’s funding stage, their call for a temporary “moratorium” was well supported in the community. Nonetheless, Stephen Tual, founder and COO of Slock.it (who had taken on a de facto corporate messaging role), assured the community that such concerns would be addressed, and that there was no need for panic. Later, in conversations with both Tual and Jentzsch, they expressed concern to me that between the unexpected success of the launch, the DAOHub’s quasi-control, and their de facto lack of control, The DAO was becoming a fearsome worry.

Between June 5th and June 9th, 2016, another issue was discovered—a technical bug this time, called a “race to empty” attack—just days before the first activities of The DAO were to begin (2016).^{vii} To address the rising tide of security issues, and to reassure an increasingly worried public, on June 13, Tual issued a statement about a 1.1 software update to The DAO framework, which had been in the works for “over a month” (2016a). This updated version purported to address the game theory issues identified by Mark, Zamfir, and Sirer (2016), as well as technical fixes for other issues, including the “race to empty” attack. However, during this time, Tual was also increasingly vocal that Slock.it did not “own” or “run” The DAO—a fact they had begun emphasizing as The DAO grew relatively large and wealthy—motivated to keep their role as hired contractor distinct from the ostensibly leaderless DAO framework. Because of the algorithmic governance structure, Tual reported to the community, the needed technical fixes (supplied for the most part by Slock.it) could not be implemented until a) The DAO token holders affirmatively voted for an up-

grade (after a proposed two-week community review), and b) Ethereum miners approved and implemented the change.

Meanwhile, as the Slock.it team was preparing the version 1.1 update and trying to move it through the community governance process for upgrading, the “race to empty” attack was out in the open. This exploit would enable an attacker to utilize the “split” function to exit the DAO while repeatedly calling a function to withdraw funds before the balance could be updated. The attack had been tested by a similar (but much smaller) DAO project called “MakerDAO,” which confirmed that it was executable, and had alerted The DAO developers about the security risk. On June 12, just prior to his prepared statement about the launch of the version 1.1 update, Tual issued a statement about this security risk, insisting that “no funds were at risk” (a statement that, while technically true, he later regretted), and that the forthcoming 1.1 software update would address this exploit (2016c).

With ostensibly no funds at risk, and little true control over the platform at this point, the Slock.it and DAOHub teams pressed forward, insisting that The DAO would stick to its original schedule, but that they *might reconsider* moving forward with new features and improvements until after “the deployment of a DAO Framework 1.1,” which was supposed to fix existing security issues (2016c). Slock.it and community members thoroughly vetted the by-now immutable code, looking for the “re-entry” bugs that had been previously identified, and found none. Besides, in theory, all The DAO funds were safe anyways, at least for the time being, due to built-in debating periods for proposals and creating new child DAOs, and a seven-day delay window for the withdrawal-like “split” action (Christoph, 2016). Therefore, Slock.it argued, token holders—malicious or otherwise—could not immediately exit The DAO. Accounting for all of the various built-in delays, the earliest date token-holders could exit with their funds was July 15, 2016. In the end, no dates would be pushed back; The DAO launched with the 1.0 framework and an upgrade path to 1.1 software (requiring community approval and review).

On June 17, 2016, an unknown “attacker” launched a “race to empty” exploit that was similar to the one that had been previously identified, and began draining The DAO of funds (in the end, 3,689,577 ETH, or about 30% of the total.). The first warning came from a Reddit community member, “ledgerwatch,” who wrote, “I think TheDAO is getting drained right now” (ledgerwatch, 2016b). Within hours, Ethereum Foundation member George Hallam roused key Ethereum developers and other pertinent members of the community to an internal Slack communication channel (some of whom were already well into a Friday night). The members confirmed the attack and started to strategize. Knowing that the attacker would want to convert the “stolen” funds into “traditional” currency, the assembled group contacted several individuals in charge at the major exchanges responsible for trading ETH, and strongly requested that these exchanges halt trading. Worried that shutting down trading would cause panic and reputational damage, and potentially suggest fiduciary malfeasance, some exchanges resisted such a drastic action, but with \$250m USD and an existential crisis for the entire Ethereum platform on the line, the major exchanges eventually relented. With nowhere to go, and counter-attacks in place, the attack relented and the funds were effectively “frozen” for the time being (due to the built-in security delay required for child DAOs and “splits” from The DAO). At this point, long-term strategies were discussed, blame was placed (the community excoriated Slock.it, and especially Tual), and a countdown clock for a solution was started.

After the exploit

Over the next month, Buterin publicly debated solutions (which ranged from immediate counter-attacks, to complicated “soft forks,” to clean and *severe* “hard forks”), the founder and CTO of Slock.it Christoph Jentzsch publically apologized, and The DAO funds continued to be attacked (and blocked through technical countermeasures). The value of ETH plummeted, and the community speculated that an unknown individual had shorted the price of ETH prior to the exploit and made millions in the

aftermath, fuelling the belief that the true purpose of the attack was to devalue ETH and make money by short selling (some of the evidence for this short sale, however, is circumspect, as it may have been a mere coincidence). Moreover, debates over solutions raged online, driven by ideologies that saw any kind of “hard fork” as tantamount to an existential deceit (a hard fork would conceptually, if not technically, erase the event from the collective and supposedly *immutable* ledger). Even more curiously, a letter purportedly written by the attacker circulated, arguing that since The DAO was defined by its code, the “exploit” was nothing more than a clever (and legal) loophole (“The Attacker”, 2016).^{viii} The letter writer and a vocal minority in the community argued that “code is law,” echoing Lawrence Lessig’s (1999) influential slogan. Therefore, they argued, any effort to block the “attacker” would be morally wrong and against the very spirit of decentralized autonomous organizations.

Within the next few weeks, with the political clout of Buterin and the Ethereum Foundation behind the decision, a “hard fork” version of the Ethereum software was developed and released to miners. This hard fork created a special “withdrawal-only” contract on the Ethereum blockchain and moved all tokens to it. A majority of miners implemented this software, and the blockchain ledger was updated to effectively erase The DAO. The DAO, and its political vision, was dead.

“Moderates” saw the hard fork as evidence of the flexibility and practicality of Ethereum and its leaders, while the more ideological saw the hard fork as censorship by a powerful cabal, or proof that blockchain technology was unable to live up to its idealistic promises. For the minority of miners who refused to update their Ethereum software—refusing the hard fork—they split from the mainline blockchain. This new blockchain—still susceptible to The DAO-style attacks—was dubbed “Ethereum Classic” and gained a somewhat significant following, even being actively traded on exchanges. Over time, the Ethereum community put The DAO experiment behind them, and talk of decentralized autonomous organizations—previously a guiding light for blockchain platforms—was thereafter tainted.

AN ETHNOGRAPHIC STUDY OF THE DAO GOVERNANCE

Seeing that my attempt to engage in participant observation research by proposing “The DAO of Whales” charity was cut short when The DAO was ignominiously cancelled and erased by the hard fork, I then begun retrospectively studying the ideals and imaginations of the community through their online discourse. Over the following year (2016-2017), this course of study brought me into contact with the discourses of hobbyist participants and investors, amounting to an ethnography of digital culture focusing primarily on the Reddit community (which I had previously identified as a primary site of discourse). My study covered online discourses in the period immediately before, during, and after The DAO.

Numerous challenges occurred in my efforts to ethnographically study The DAO. Very little empirical research on cryptocurrencies and blockchains exists today. The research that does exist is predominantly quantitative in nature, and from a socio-economic perspective. The only existing *qualitative* study of actors and communities that I am aware of is Lustig and Nardi’s (2015) analysis of the Bitcoin community. Consequently, there are very few research models to follow (qualitative research of online communities, in general, remains a challenge), and there is scant contextual data about these communities to help guide and ground my own research.

Nonetheless, Lustig and Nardi (2015) do provide a compelling snapshot of the composition, beliefs, and values of the Bitcoin community (and by extension, the larger cryptocurrency and blockchain community).^{ix} In their study, they used Grounded Theory Methodology with an initial thirty-six question online survey and a follow-up series of interviews (with participants identified from the initial survey). Twenty-two participants were interviewed, and Lustig and Nardi found (perhaps unsurprisingly) that most members of the cryptocurrency and blockchain community believed algorithms were more trustworthy and authoritative than existing socio-political institutions. Yet, the views and values of the

Bitcoin community were divided and complex—Lustig and Nardi reported that the community “recognized that it is not enough to just trust in the code” (2015: 751). This complex and sometimes contradictory view of trust and authority meant that other Bitcoin users needed to be trusted and consulted while using the cryptocurrency (especially when it came to matters of trading strategy), but that the technical structure of Bitcoin (using a “proof of work” network of “miners” cryptographically authenticating transactions) obviated worries about counterfeited coins or counterparty risk. Moreover, the development of the Bitcoin software itself, Lustig and Nardi pointed out (2015: 751), required complex socio-technical negotiations.

Research Method

My research used a variant of Grounded Theory Methodology; specifically, I followed Merriam and Tisdell’s (2016) “Basic” qualitative method. Merriam and Tisdell characterise this method as richly descriptive, emergent, and flexible. Key to this “Basic” method is recognizing that existing bias—the expertise of the researcher—is a strength to the development of theory, by which the researcher works from observed behaviours and discourses to thick theories of human and social interaction.

Data were collected from online sources, in a retrospective fashion. Since The DAO had already ended, I used written traces of discourse from several online sources. In my initial research, I identified the Reddit community as being the richest source of non-technical discourse, especially since this community appeared to be comprised of both insiders and outsiders to The DAO. Within the larger Reddit community (organized around thematic “sub-Reddits”) I found that the Ethereum sub-Reddit (/r/Ethereum) was the most vibrant and interesting place for online discussion of The DAO (unexpectedly, the /r/TheDAO sub-Reddit was less active). Therefore, I focused my data collection on the Ethereum Reddit community, but also researched broadly across blogs, technical websites, and news media as well.

DuPont, Quinn. Experiments in Algorithmic Governance: A history and ethnography of “The DAO,” a failed Decentralized Autonomous Organization.” (ed. Malcolm Campbell-Verduyn) *Bitcoin and Beyond: Cryptocurrencies, Blockchains and Global Governance* (forthcoming).

Data were retrieved using opportunistic search queries across the entirety of the Reddit platform (global searches), and by following links and leads in an investigative manner with no predefined scope limitations. Additionally, data were collected from the Ethereum sub-Reddit *systematically* through June/July 2016 (the two months surrounding the exploit), using an online search tool to display sub-Reddit posts in chronological order. Discussions of interest (determined by a quick initial skim read) were captured as PDF files, and ingested to Atlas.ti software for later processing (seventy-three PDF documents, each ranging from a few pages to fifty-plus pages, were ingested).

Once the Reddit discussions were ingested into Atlas.ti, I performed a form of “open coding” for qualitative content analysis. This method is similar to the constant comparative method developed by Glaser and Strauss (1967). I reflexively, iteratively, and interactively grouped, renamed, and abstracted data while building towards categories (a form of “axial coding”). My method of analysis was purposely loose and pragmatic, not high-minded analysis driven by formalities. Merriam and Tisdell espouse this deflationary view of qualitative data analysis for their “Basic” method: “Coding is nothing more than assigning some sort of shorthand designation to various aspects of your data so that you can easily retrieve pieces of the data” (2016). As I developed categories, I constantly returned to the data and reevaluated my codes and categories, using my existing insights about cryptocurrency discourses to guide my decisions. I developed twenty-three codes over the seventy-three ingested documents (in addition to identifying 534 illustrative quotations). I soon learned that chronology became the most critical axis of analysis (files were renamed in Atlas.ti using their origin date to facilitate ordering), since discourse about The DAO shifted significantly before, during, and after the exploit.

Given the highly decentralized nature of the underlying blockchain technology and cryptocurrency’s origins in cipherpunk and Internet culture, I felt justified in focusing solely on online discourses for data collection, since my previous experience told me that blockchain communities are especially

well represented online. Nonetheless, the Reddit community constitutes a very particular snapshot of larger cryptocurrency discourse, and has its own form of rhetoric and shared lore. As such, my study cannot be understood as fully representative of all participants in The DAO (and certainly, Tual and Jentzsch, whom I spoke with later, disagree with many of the opinions expressed by the Reddit community). Moreover, Reddit discourse is “semi-public” and pseudonymous in nature, and often has a “performative” quality.^x Additionally, given the extensive, decentralized, and often secret nature of cryptocurrency participants (and especially their trading strategies), there is almost certainly a shadow element not at all represented in the public discourses that I investigated. In fact, my past experiences within the community suggest that a significant number of cryptocurrency users are primarily “investors” interested in little more than high-risk profit, and therefore are motivated by economic incentives, which may also be underrepresented in the vibrant online discourses (with an inverse overrepresentation of idealist and polemic discourses existing online). Nonetheless, my analysis revealed hints at these and other complex motivations in the online communities.

Results

The DAO provides a compelling and rich snapshot of unrealized dreams, visions of new worlds, and quotidian struggle. Because The DAO ended in disaster, the results also speak to literatures on crisis and the governance thereof. Specifically, I am drawn to Samman’s analysis (2015) of crisis and historical imagination, which conceives of crisis as both overdetermined and indeterminate. In the case of The DAO, there were numerous internal contradictions that overdetermined a single narrative history, and The DAO remained indeterminate because it was shuttered before long-term dynamics of governance could be further explored. Moreover, as a moment of crisis, the experimental goals that The DAO originally set out to achieve have yet to be brought to fruition. Therefore, assessing the governance of The DAO, and seeking sensible solutions and options for

addressing risk (see Saurwein et al., 2015), remains a significant challenge.

Of the many potential themes that emerged in the complex discourses on The DAO, I identified three related to issues of governance: legal authority, practical governance, and the experimental nature of using algorithmic systems for distributed action.

Legal Authority

Legal authority is now a well-known “issue” in the cryptocurrency and blockchain world. For years, strong (idealistic) proponents of blockchain technology have advocated that “code is law.”^{xi} In the academic literature, this articulation of “code is law” has been described as a form of “algorithmic authority”—first identified by Clay Shirky (2009) and then later Frank Pasquale (as “automated authority”) (2011), among others. In much of this literature, in direct opposition to the idealistic proponents of blockchain technology, the concept of algorithmic authority is characterized critically, as tantamount to the biopolitical technologies that go about unknown by, and against the interests of, its subjects (Introna, 2016).

Lustig and Nardi (2015) characterize the Bitcoin community’s beliefs about legal authority through the lens of algorithmic authority. In their analysis, they identified a complex array of views on algorithmic authority, and they found that according those in the Bitcoin community, the presence of algorithmic authority is not uniformly negative. Similar views about the role of algorithmic authority were also found in the discourses on The DAO. As I mentioned above, the person who purportedly exploited The DAO also wrote a letter to the community, arguing from this very position of algorithmic authority—that he or she “rightfully claimed 3,641,694 [*sic*] ether” by exploiting a “feature” of The DAO that was designed to “promote decentralization” (“The Attacker”, 2016). Others in the community were also sympathetic to this view (despite sometimes being in a position to potentially lose a significant number of valuable tokens due to this very model of legal authority).

Therefore, rather than simply adopt a critical, normative position when assessing the community discourses on algorithmic authority, I reference a model of algorithmic authority in terms of its governance relations (Campbell-Verduyn et al., 2017). Using this model, I argue that the forms of algorithmic authority present in the discourses on The DAO properly exist in a continuum—as governance through algorithms, governance with algorithms, and governance by algorithms.

Those attuned to formal understandings of law will likely find the notion of algorithmic authority—as exemplified by the argument put forth in the attacker’s letter—galling and borderline humorous. As though intent could not or does not play an important role in law, or that a Terms of Service Agreement (which the attacker also cites) could trump common sense and legal process. Nonetheless, the concept of algorithmic authority crystalizes a point that many in The DAO community held—The DAO was supposed to represent a turning point in legal authority, where code really does form a new legal regime. For example, “IAMnotA_Cylon” (2016) argued that “Ethereum worked exactly as intended,” and “Polycephal_Lee” (2016) argued that the exploit was “the protocol working as it was written.” On the other hand, “UntamedOne” (2016) argued that “we don’t live in this idealistic cryptoanarchy world *yet*” (emphasis added). For those in The DAO community, many (but certainly not all) saw The DAO as a realization of new form of legal authority. Nonetheless, the subsequent exploit also helped expose the tensions necessarily present in the space between algorithmic and existing, juridical legal authority.

Some members of The DAO community expressed concerns about this tension. Early on, these voices also included Slock.it’s, which attempted to balance this legal tension by rhetorically distancing itself from fiduciary involvement of The DAO, seemingly for fear of legal reprisal (and many community members picked up on this maneuvering). A clear example of the latent tensions between utopia and reality was expressed by Tual in an early blog post (March 1, 2016), entitled “DAOs, or how to Replace Obsolete Governance Models” (2016b).

This blog post announced the coming realization of a practical technology for “anyone, anywhere in the world to set up a Decentralized Autonomous Organization” (later known as The DAO), which included the proviso that “if you create a DAO... [using our software] you will be responsible for its operation” (Tual, 2016b). Somewhat more skeptically, others noted that The DAO nonetheless involved “real people” (ledgerwatch, 2016a), which may or may not be able to “legally own assets” given the unique structure of ownership under existing law (Dunning_Krugerrands, 2016). Showing concern for the ways that existing legal authority might impinge on their collective experiment, taxes, regulation, and liability were also frequent points of conversation in the community.

Many members of The DAO community saw their experiment as embarking on a new legal world, and devised strategies to make this world a reality. Reddit community member “ledgerwatch” (and later, the individual to first discover The DAO exploit), thought that “the necessary legal framework” for The DAO could be “grown bottom up... [from] within the current legal system” (ledgerwatch, 2016a). This individual then invoked *Lex mercatoria*, or medieval merchant law, as a model for how The DAO might find its legal footing within the existing legal system (ledgerwatch, 2016a). Presumably, medieval merchant law was a suitable model on account of its rough-and-ready and pragmatic way of dealing with legal issues (medieval merchant law sat outside of more formal legal processes). For The DAO, this kind of pragmatism became a form of real governance, as seen in the views of those community members who believed the post-exploit hard fork was an example of pragmatic, good governance.

Practical Governance

On the continuum of governance made possible by algorithmic technologies, practical governance (or governance *of* algorithms) is a key issue facing society today. The existence of autonomous weapons, self-driving cars, and, of course, The DAO, all throw into relief the challenge of socially integrating these technologies, through forms of risk manage-

ment, internal design and development, market solutions, industry self-regulation, and state and government regulation (Saurwein et al., 2015).

Once the exploit of The DAO took place, the previously existing ideals of algorithmic authority held by The DAO developers and supporters were thrown into disarray, and the project entered crisis mode. Slock.it and others attempted to assure a nervous public that the exploit did not threaten any funds and that it was “business as usual” (in the end, no funds were actually stolen) (carloscarlson, 2016). Some of these community members saw the exploit as an expensive lesson in “real life” (“Let the DAO burn” wrote “GeorgesTurdBlossom,” 2016), or perhaps one that would motivate further development in security for decentralized autonomous organizations. Others, however, thought that a solution lied in the realization that, despite ideals and heaps of rhetoric about decentralization and immutability, good governance was flexible and pragmatic. For instance, some argued that this was a “maturing of the ecosystem” (Floersch, 2016) or a “rite of passage” (Siner, 2016). For these individuals, which included Buterin, a hard fork was an obvious choice when faced with an existential crisis of this nature (vbuterin, 2017).

In these discussions, the issue of “centralized” governance emerged in parallel to factions in the community. Hardliners saw Buterin’s and the Ethereum Foundation’s support of a hard fork as tantamount to the bank bailouts following the 2008 global credit crisis. “DonaldCruz” wrote, jokingly, “good thing we have a central authority to come to the rescue when shit hits the fan” (DonaldCruz, 2016). And “Eldakara” wrote, “Ah..[sic] So decentralized protocols come with centralized bailouts now” (Eldakara, 2016). By accepting “centralized” governance in the form of a hard fork, instead of sticking with flawed but pure algorithmic authority, “itworks123” believed it was “like saying we should delay democracy until things are ‘perfect’” (itworks123, 2016). On the other hand, many community members pushed back against this logic, perhaps motivated by saving their personal investment stake in The DAO, or perhaps by a thicker sense of the social embeddedness of technological systems.

Summarizing this position, “DavidMc0” wrote, “decentralized doesn’t need to mean static, stupid, or powerless against attackers” (DavidMc0, 2016).

An important part of the model of practical governance for The DAO rests on the view that it made a break with past forms of governance and that the exploit merely highlighted the ways that reality had not yet caught up to these new models. Looking toward technical developments that would create forms of algorithmic authority enabling a more robust and nuanced mode of governance, “redditbsbsbs” writes: “we can argue about full decentralization and autonomy post Serenity” (redditbsbsbs, 2016). Here, “Serenity” is the name of a point in the Ethereum development roadmap, but tellingly, also a rhetorical emblem of an imagined state of affairs, when algorithmic governance reaches peace and serenity.

Experiments in distributed action

From the earliest days of The DAO, many community members acknowledged that the enormous complexity of decentralized and algorithmic governance required a new kind of experimental “science” (dm1n1c, 2016) to map the “uncharted territory” The DAO was entering (laughing__cow, 2016). This new science was understood as, and promised to be, governance *by* algorithms. Bringing to light this science of society, however, required both a pioneering spirit and a new model of distributed action.

This logic and rhetoric of “experiment,” “confusion,” and “newness” pervaded discussions about how action could be coordinated using a decentralized technology platform. Summarizing the tension between a sound “investment” and a “recipe for chaos,” one Reddit member noted that this kind of collective action is “dependent on an experimental, first-of-its kind DAO platform” (xxeyes, 2016). The DAO was also surprisingly complex in terms of coordinating actors, with vigorous debates about the role of Slock.it, curators, developers, miners, the Ethereum Foundation, and the community of token holders. When the collective “community is in charge,” people worried, where do rights and duties fall (cubefriendly, 2016)?

Coordinating interests and actions across a range of actors with often very different incentives is a central challenge to designing many decentralized information communication technologies, including the Internet. The development of The DAO, as a model for future decentralized autonomous organizations, was an ideal site of exploration for experimenting with these incentive structures. One of the key actors in this regard is Vitalik Buterin, who has demonstrated a sophisticated, if at times blinkered, view of incentive and distributed action. In his online writing, he has come up with numerous game theoretical models to assure honesty, compliance, and other means for distributed action, which in turn, can be instantiated in algorithms to produce authority and governance. Buterin’s emerging and much-lauded “Proof of Stake” algorithm (replacing the now, much maligned, “Proof of Work” algorithm originally used in Bitcoin) is one such direct result of this kind of musing. Perhaps because it is so amenable to implementation in technical systems (a form of “computationalism;” Golumbia, 2009), rational actor and game theory have become key ways of modelling complex social properties in blockchain and cryptocurrency systems.

The exploit of The DAO, however, inevitably belied much of this sophisticated theory. The exploit shone a light on the shortcomings of these assumptions, or at least, reminded the actors of the enormous complexity of socially-embedded systems. It was believed that action could be coordinated through technology, or at least enhanced by it, with the application or operationalization of games or bets. Beneath the methods of coordinating action, however, The DAO relied on a model of human behaviour and social constitution notionally based on liberal ideologies, where humans act as rational, self-interested, and untrusting agents (see Reijers et al., 2016; Scott, 2014). Inevitably, however, when governance of The DAO deviated from the expected course of events (those modelled in game theory by the designers), the social actors fell back to traditional strong network ties. In doing so, governance of The DAO discredited its ideological underpinnings, and even exposed a worrisome lack of mana-

gerial prowess that would typically use forms of rationalizing behaviour drawn from risk management or crisis mediation.

The resolution of the exploit, through the eventual and final hard fork, was ultimately a hurried private discussion among known individuals, and bore little resemblance to theoretical modes of incentivizing and distributing action (see Hallam et al., 2016). Despite The DAO's experimentation, operationalizing algorithmic governance in society still requires awareness of implied and undeclared social goods (Levy, 2017), and any future design will need to contend with these challenges.

Discussion

I have not written with the goal of any strong conclusions to the many contentious issues present in The DAO or the broader themes revealed in this chapter. Rather, I have identified some of the ways that governance was *believed to* function in decentralized autonomous organizations, and the ways that it *did* function.

The DAO is an important artefact for attempting to understand emerging forms of algorithmic authority, working through practical modes of governance for autonomous and decentralized systems, and for understanding the ways that designing incentives and modelling action can fail. Its emergence and technical structure formally relates to ongoing discussions about the ethics of autonomous warfare, automated and high-frequency finance, and big data. Despite the utopian rhetoric on the one hand, and the largely critical academic literature on the other, what remains unclear with these technologies is whether they constitute an extension of existing socio-technical apparatuses, or are a decisive break with the past. What is clear, The DAO proved, is that these technologies have significant potential for real impact and harm, and therefore ring early warning alarms for the critical investigation of modes of governance beyond those already designed.

After the exploit, The DAO was formally shuttered, but in the conflictual community response that ensued there lies an interesting coda to its broader narrative. When the hard fork was proposed

as a "fix" to the exploit, a vocal minority opposed it. While it is not entirely clear who opposed the hard fork, in their opposition, many "miners" declined to accept the hard fork software and therefore continued to mine the old blockchain. In doing so, the incentives (and capabilities) of the miners became critically misaligned with the incentives of the majority of The DAO community. By mining the old blockchain, the miners forged a new cryptocurrency, later called "Ethereum Classic" or ETC. Ethereum Classic would itself become a strange investment vehicle that created economic "value" out of thin air (not unlike all cryptocurrencies), underpinned by nothing more than vague idealism and a dogged interest in financial returns.

In the end, I think Ethereum Classic represents the story of The DAO fairly well. For all the dreams and visions contained in the rhetoric about The DAO, tracing the history of The DAO left me wondering if more than a tiny handful of individuals ever actually believed in the possibility and true benefit of a decentralized autonomous organization. It struck me that, like so many cryptocurrency and blockchain technologies, The DAO might have been just a high-risk investment vehicle masquerading as a new way of doing things.

Despite my cynicism, The DAO also introduced an interesting, relatively small-scale technology for experimenting with governance issues and new models of society. Indeed, perhaps this characterization can also be extended beyond matters of governance and beyond The DAO itself—should we see cryptocurrencies and blockchain technologies more broadly as apparatuses for socio-technical experimentation in society? That is, in the end, perhaps The DAO simply did not survive long enough to work out the kinks in a promising new kind of governance. Or, perhaps hype and exuberance got in the way of a good idea, whose time will come someday, which was first charted by these intrepid explorers?

In this chapter I detailed the brief history of The DAO, and offered an analysis of its modes of governance. To do so, I performed retrospective, ethno-

graphic research of The DAO community by focusing on online discourse. I found three key themes of governance emerge from this discourse: 1) the shift of legal authority from existing, juridical authority to algorithmic authority; 2) the difficulty of designing and governing algorithmic systems, and especially immutable and decentralized ones; and 3) the challenging ethical terrain of experimentation with forms of distributed action through autonomous, decentralized systems.

Acknowledgments

Funding for this research was provided by the University College Dublin Center for Innovation, Technology, and Organization. I hold a small amount of cryptocurrency for research purposes, including Ethereum and (previously) The DAO tokens.

Thanks to Gianluca Miscione, Paul Ennis, Donncha Kavanagh, and Bill Maurer for commentary and guidance. Thanks for Stephan Tual and Christoph Jentsche for commentary on an early draft. Initial qualitative research on The DAO was also conducted by Melissa K. Wrapp and shared with me, providing an invaluable aid in the early stages of this research. Malcolm Campbell-Verduyn provided welcome editorial assistance.

References and Notes

A2be. 2016. An historical note on the creation of The DAO. *DAOhub.org*. Available from: <https://forum.daohub.org/t/an-historical-note-on-the-creation-of-the-dao/6377> (accessed 7 April 2017).

Bichler, S. and Nitzan, J. 2004. Dominant Capital and the New Wars. *Journal of World-Systems Research* 10(2): 254–327.

Campbell-Verduyn, M., Goguen, M., and Porter, T. 2017. Big Data and algorithmic governance: the case of financial practices. *New Political Economy* 22(2): 219–236.

carloscarlson. 2016. ‘No hard fork’ does NOT mean ‘DAO holders lose all their ETH’. This debate is being rushed - let’s examine ALL options. *reddit*. Available from: <https://www.red->

[dit.com/r/ethereum/comments/4op69x/no_hard_fork_does_not_mean_dao_holders_lose_all/](https://www.reddit.com/r/ethereum/comments/4op69x/no_hard_fork_does_not_mean_dao_holders_lose_all/) (accessed 10 April 2017).

Christoph. 2016. How to split the DAO: Step-by-Step. *The DAO*. Available from: <https://daowiki.atlassian.net/wiki/display/DAO/How+to+split+the+DAO%3A+Step-by-Step> (accessed 7 April 2017).

cubefriendly. 2016. ‘The DAO’ does not invest in Slock.it, it will hire the slock.it team to build the USN (Universal Share Network) for ‘the DAO’. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4ij7d7/the_dao_does_not_invest_in_slockit_it_will_hire/ (accessed 10 April 2017).

DavidMc0. 2016. Ether Safe - But DAO cancelled. We’re getting a refund. *reddit*. Available from: https://www.reddit.com/r/TheDao/comments/4oieip/ether_safe_but_dao_cancelled_were_getting_a_refund/ (accessed 10 April 2017).

dm1n1c. 2016. The DAO debate & the Ethereum Autonomous Finance DAO. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4gz43z/the_dao_debate_the_ethereum_autonomous_finance_dao/ (accessed 10 April 2017).

DonaldCruz. 2016. DAO IS SAFE. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4oiib4/dao_is_safe/ (accessed 10 April 2017).

Dunning_Krugerrands. 2016. Don’t wait for Slock.it DAO announcement - there won’t be any. *reddit*. Available from: https://www.reddit.com/r/ethtrader/comments/4dtlvc/dont_wait_for_slockit_dao_announcement_there_wont/ (accessed 9 April 2017).

Eldakara. 2016. F*ck this DAO. *reddit*. Available from: https://www.reddit.com/r/ethtrader/comments/4oif5c/fck_this_dao/ (accessed 10 April 2017).

- Epstein, C. 2005. *The Power of Words in International Relations: Birth of an Anti-Whaling Discourse*. MIT Press.
- Floersch, K. 2016. The Ether Review #31 — Aftermath, Discussing the DAO Hack. *ConsenSys Media*. Available from: <https://media.consen-sys.net/the-ether-review-31-aftermath-discussing-the-dao-hack-8afcb52575f9> (accessed 10 April 2017).
- GeorgesTurdBlossom. 2016. We want unstoppable contracts. Let the DAO burn. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4ozzd/v/we_want_unstoppable_contracts_let_the_dao_burn/ (accessed 10 April 2017).
- Glaser, BG. and Strauss AL. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine Publishing Company.
- Golumbia, D. 2009. *The Cultural Logic of Computation*. Cambridge, MA: Harvard University Press.
- Hallam, G., Shihara, B., Buterin, V., et al. 2016. Untitled. *Pastebin.com*, Paste Site. Available from: <https://pastebin.com/aMKwQcHR> (accessed 10 April 2017).
- IAMnotA_Cylon. 2016. Critical update RE: DAO Vulnerability. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4oiqj7/critical_update_re_dao_vulnerability/ (accessed 9 April 2017).
- Introna LD. 2016. Algorithms, Governance, and Governmentality: On Governing Academic Writing. *Science, Technology & Human Values* 41(1): 17–49.
- itworks123. 2016. Ether Safe - But DAO cancelled. We're getting a refund. *reddit*. Available from: https://www.reddit.com/r/TheDao/comments/4oisep/ether_safe_but_dao_cancelled_were_getting_a_refund/ (accessed 10 April 2017).
- Jentsch, C. 2016. Decentralized Autonomous Organization to Automate Governance. Available from: <https://github.com/slockit/DAO/tree/develop/paper>
- laughing__cow. 2016. To the community. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4p521a/to_the_community/ (accessed 10 April 2017).
- ledgerwatch. 2016a. Don't wait for Slock.it DAO announcement - there won't be any. *reddit*. Available from: https://www.reddit.com/r/eth-trader/comments/4dtlvc/dont_wait_for_slockit_dao_announcement_there_wont/ (accessed 9 April 2017).
- ledgerwatch. 2016b. I think TheDAO is getting drained right now. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4oi2ta/i_think_thedao_is_getting_drained_right_now/ (accessed 7 April 2017).
- Lessig, L. 1999. *Code and other laws of cyberspace*. New York: Basic Books.
- Levy, KEC. 2017. Book-Smart, Not Street-Smart: Blockchain-Based Smart Contracts and The Social Workings of Law. *Engaging Science, Technology, and Society* 3(0): 1–15.
- Lustig, C. and Nardi, B. 2015. Algorithmic Authority: The Case of Bitcoin. In: IEEE, pp. 743–752. Available from: <http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=7069744> (accessed 28 April 2016).
- Mark, D., Zamfir, V. and Sirer. 2016. A Call for a Temporary Moratorium on 'The DAO'. Available from: https://docs.google.com/document/d/10kTyCmGPhvZy94F7VWys-dQ4lsBacR2dUgGTtV98C40/edit?usp=embed_facebook (accessed 7 April 2017).
- Merriam, SB. and Tisdell, EJ. 2016. *Qualitative Research?: A Guide to Design and Implementation*. 4th ed. San Francisco: Jossey-Bass.
- Pasquale, F. 2011. Restoring Transparency to Automated Authority. *Journal on Telecommunications & High Technology Law* 9(235): 235–256.
- Polycephal_Lee. 2016. Critical update RE: DAO Vulnerability. *reddit*. Available from:

- https://www.reddit.com/r/ethereum/comments/4oiqj7/critical_update_re_dao_vulnerability/ (accessed 9 April 2017).
- redditsbsbs. 2016. Ether Safe - But DAO cancelled. We're getting a refund. *reddit*. Available from: https://www.reddit.com/r/TheDao/comments/4oisp/ether_safe_but_dao_cancelled_were_getting_a_refund/ (accessed 10 April 2017).
- Reijers, W., O'Brolcháin, F., and Haynes, P. 2016. Governance in Blockchain Technologies & Social Contract Theories. *Ledger* 1(0): 134–151.
- Ryan, DM. 2016. The DAO: An experiment in responsibility. Available from: <http://enterstagright.com/archive/articles/0516/dao.htm> (accessed 7 April 2017).
- Samman, A. 2015. Crisis theory and the historical imagination. *Review of International Political Economy* 22(5): 966–995.
- Saurwein, F., Just, N. and Latzer, M. 2015. Governance of algorithms: options and limitations. *Info : the Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media* 17(6): 35–49.
- Schroeder, K. 2014. Deodands: DACs for natural systems. *Ethereum Forum*. Available from: <https://forum.ethereum.org/discussion/392/deodands-dacs-for-natural-systems> (accessed 12 May 2016).
- Scott, B. 2014. Visions of a Techno-Leviathan: The Politics of the Bitcoin Blockchain. *E-International Relations*. Available from: <http://www.e-ir.info/2014/06/01/visions-of-a-techno-leviathan-the-politics-of-the-bitcoin-blockchain/> (accessed 30 April 2016).
- Shirky, C. 2009. A Speculative Post on the Idea of Algorithmic Authority. *Clay Shirky*, blog. Available from: <http://www.shirky.com/weblog/2009/11/a-speculative-post-on-the-idea-of-algorithmic-authority/> (accessed 7 April 2017).
- Sirer, EG. 2016. The Ether Review #36 — Emin Gün Sirer, Wrapping it all up. *ConsenSys Media*. Available from: <https://media.consen-sys.net/the-ether-review-36-emin-g%C3%BCn-sirer-wrapping-it-all-up-4d6c4280faa4> (accessed 10 April 2017).
- 'The Attacker'. 2016. An Open Letter. *Pastebin.com*. Available from: <https://pastebin.com/CcGUB-gDG> (accessed 7 April 2017).
- Tual, S. 2016a. Announcing DAO Framework 1.1. *Slock.it Blog*. Available from: <https://blog.slock.it/announcing-dao-framework-1-1-35249e2e001#.uav8dw16j> (accessed 7 April 2017).
- Tual, S. 2016b. DAOs, or how to replace obsolete governance models. *Slock.it Blog*. Available from: <https://blog.slock.it/daos-or-how-to-replace-both-the-kickstarter-and-token-presale-models-1b2b8898d6e7> (accessed 9 April 2017).
- Tual, S. 2016c. No DAO funds at risk following the Ethereum smart contract 'recursive call' bug discovery. *Slock.it Blog*. Available from: <https://blog.slock.it/no-dao-funds-at-risk-following-the-ethereum-smart-contract-recursive-call-bug-discovery-29f482d348b#.dt2soywp> (accessed 7 April 2017).
- UntamedOne. 2016. Critical update RE: DAO Vulnerability. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4oiqj7/critical_update_re_dao_vulnerability/ (accessed 9 April 2017).
- vbuterin. 2017. Personal statement regarding the fork. *reddit*. Available from: https://www.reddit.com/r/ethereum/comments/4oj7ql/personal_statement_regarding_the_fork/ (accessed 10 April 2017).
- Vessenes, P. 2016. More Ethereum Attacks: Race-To-Empty is the Real Deal. *Peter Vessenes*. Available from: <http://vessenes.com/more-ethereum-attacks-race-to-empty-is-the-real-deal/> (accessed 7 April 2017).
- xxeyes. 2016. The DAO: Risk-free short term investment; high-risk long term investment. Is this a recipe for chaos? *reddit*. Available from: https://www.reddit.com/r/ethtrader/comments/4h80xm/the_dao_riskfree_short_term_investment_highrisk/ (accessed 10 April 2017).

ⁱ Values and dates for The DAO were initially collected through online sources, but later confirmed and adjusted to correspond with internal data provided by Stephan Tual of Slock.it. The largest discrepancy between publically-reported values and internal values is the maximum USD-converted monetary value of The DAO, which online sources claimed reached a maximum of \$150m. Using historical market data, Slock.it's internal data showed a maximum of \$250m, from 11,944,260.98 ETH. Due to wild ETH price swings during this period, the USD-converted monetary value changed rapidly.

ⁱⁱ At the time of writing, examples include MakerDAO, Wings DAO, Digix Global, Augur, and Token-Funder.

ⁱⁱⁱ It is even possible to have low-trust/high-honesty human input through an “oracle” arrangement. In the context of blockchain human-machine organizations, these oracles can use economically-incentivized prediction markets (e.g., TrustCoin, Augur), a game-theory setup (e.g., SchellingCoin), or even just simple multiple-signature ledgers to reduce the possibility of human cheating when reporting answers to oracle questions.

^{iv} There is also a group of individuals misleadingly called “curators,” who are responsible for the overall maintenance of “The DAO” platform, but despite their title they do not control or curate which projects are funded.

^v One known risk about this arrangement, however, is the possibility of the majority robbing the minority. If a majority shareholder decided to create a rule that stipulated, say, all funds were to be disbursed to majority stakeholders only, then this (majority) stakeholder could also approve such a rule, and therefore rob the minority. Slock.it was aware of this issue, and designed an odd “split” mechanism for funders to leave a DAO before decisions could be implemented (which utilized built-in delays). The split mechanism was later used during the exploit, but the built-in delays prevented the attacker from successfully exiting The DAO with any funds.

^{vi} The idea of a deodand is now part of legal lore, but with recent rulings such as *Citizen's United v. Federal Election Commission*, which effectively made it possible for corporations to act like people (at least for campaign spending), I argue that the idea of a deodand is no longer far-fetched.

^{vii} A version of the attack was originally identified by Christian Reitwiessner, and reported to key developers four days prior (Vessenes, 2016).

^{viii} It must be stressed that it is very unlikely this letter is authentic. Nonetheless, the letter beautifully crystallizes the views of many people in the community, and is therefore an important source for understanding the dynamics of governance in The DAO.

^{ix} One must, however, use caution when extrapolating between cryptocurrency and blockchain communities, since each has its own history and values. For example, the Bitcoin community is famously anti-authoritarian in comparison to Ethereum or, even more so, any number of the financial technology organizations using blockchain and “distributed ledger technology.” The latter tend to be incentivized to work within existing capital institutions, whereas the former tend to want to replace the existing economic system.

^x Performative discourse is an especially acute issue for cryptocurrency communities, which suffer from a well known “pump and dump” problem. Individuals attempt to convince others of the value or future value of a currency that he or she already owns a stake in (using traditional rhetorical strategies or pseudo-scientific analytical “projections”), in order to drive up the currency price and then sell at profit.

^{xi} Although it is rarely appreciated in cryptocurrency and blockchain discourses, Lessig's original (1999) version of the “code is law” slogan argued that algorithmic permissions obviate the very category of law—not that the code constitutes a new form of law. In Lessig's version, if code prevents the activity in the first

place (such as sharing an MP3 file under a fair use / fair dealings exemption), then the appropriate laws do not even have a chance to be invoked, since there is no (potentially illegal) action to be considered.