CHAPTER 4

RE-ARCHITECTING THE FIRM:

THE CORE AND THE EDGES

BUILDING CONSENSYS

July 30, 2015, was a big day for a global group of coders, investors, entrepreneurs, and corporate strategists who think that Ethereum is the next big thing—not just for business, but possibly for civilization. Ethereum, the blockchain platform eighteen months in the making, went live.

We witnessed the launch firsthand in the Brooklyn office of Consensus Systems (ConsenSys), one of the first Ethereum software development companies. Around 11:45 a.m., there were high fives all around as the Ethereum network created its "genesis block," after which a frenzy of miners raced to win the first block of ether, Ethereum's currency. The day was eerily suspenseful. A massive thunderstorm broke over the East River, triggering loud and random emergency flood warnings on everyone's smart phones.

According to its Web site, Ethereum is a platform that runs decentralized applications, namely smart contracts, "exactly as programmed without any possibility of downtime, censorship, fraud, or third party interference." Ethereum is like bitcoin in that its ether motivates a network of peers to validate transactions, secure the network, and achieve consensus about what exists and what has occurred. But unlike bitcoin it contains some powerful tools to help developers and others create software services ranging from decentralized games to stock exchanges.

Ethereum was conceived in 2013 by then-nineteen-year-old Vitalik Buterin, a Canadian of Russian descent. He had argued to the bitcoin core developers that the platform needed a more robust scripting language for developing applications. When they rejected him, he decided to craft his own platform. ConsenSys was first off the block, so to speak, launched to create Ethereum-based apps. Flash-forward a couple of years and the analogy is clear: Linus Torvalds is to Linux what Vitalik Buterin is to Ethereum.

When discussing the rise of blockchain and Ethereum technology, Joseph Lubin, ConsenSys's cofounder, said, "It became clear to me that instead of people wasting their time walking down the street with posters on sticks, we could all work together to just build the new solutions to this broken economy and society."[1] Don't occupy Wall Street. Invent our own street.

Like many entrepreneurs, Lubin has a bold mission, not just to build a great company but to solve important problems in the world. He deadpans that the company is a "blockchain venture production studio, building decentralized applications, mostly on Ethereum." Pretty low-key. But, if implemented, the applications that ConsenSys is building would shake the windows and rattle the walls of a dozen industries. Projects include a distributed triple-entry accounting system; a decentralized version of the massively popular Reddit discussion forum, plagued of late by controversy over its centralized control; a document formation and management system for self-enforcing contracts (aka smart contracts); prediction markets for

business, sports, and entertainment; an open energy market; a distributed music model to compete with Apple and Spotify, though those two firms could use it too;[2] and a suite of business tools for mass collaboration, mass creation, and mass management of a management-less company.

Our story of ConsenSys is not so much about its ambitious blockchain-based products or services. It's about its efforts to cultivate a company of its own, pioneering important new ground in management science along the lines of holacracy, a collaborative rather than hierarchical process for defining and aligning the work to be done. "While I don't want us to implement holacracy as is—it feels way too rigid and structured to me—we are working to incorporate many of its philosophies in our structure and processes," said Lubin. Among those holacratic tenets are "dynamic roles rather than traditional job descriptions; distributed, not delegated authority; transparent rules rather than office politics; and rapid reiterations rather than big reorganizations," all of which describe how blockchain technologies work. How ConsenSys is structured, how it creates value, and how it manages itself differs not only from the industrial corporation but also from the typical dot-com.

Joe Lubin is not an ideologue, and certainly not an anarchist or libertarian as some in the cryptocurrency movement are. But he does think that we need to change capitalism if we want it to survive, specifically to move away from the command-and-control hierarchies inappropriate for a networked world. He notes that today, even though vast networks enmesh the world and enable us all to communicate inexpensively, richly, and immediately, hierarchies prevail. Blockchain technology is the countervalence: "Global human society can now agree on the truth and make decisions in ten minutes, or ten seconds. This surely creates an opportunity to have a more enfranchised society," he said. The greater the engagement, the greater the prosperity.

The End of Managers. Long Live Management

ConsenSys operates according to a plan that all employees ("members") developed, modified, voted on, and adopted. Joe Lubin describes its structure as a "hub" rather than a hierarchy, and each of its projects is a "spoke" in which major contributors hold equity.

For the most part, members of ConsenSys choose what they work on. No top-down assignments. Lubin said, "We share as much as possible, including shared software components. We build small agile teams but there is collaboration among them. We have tons of immediate, open, rich communication." Members choose to work on two to five projects. When someone sees a piece of work that needs to get done, he or she jumps in and pushes it a little or a lot farther in a valuable direction, as appropriate for her role. "We talk about things quite a bit so people are aware of the many things that could be pushed forward," he said. But these many things can and do change constantly. "Part of being agile means that priorities are dynamic."

Lubin is not the boss. His main operational role is advisory: "In many cases, individuals ask me or others what would be good to work on," he said. Through Slack[3] and GitHub,[4] he suggests directions they might pursue "to build all the services and platforms that we want to build, and many that we want to build but don't know it yet."

Member ownership explicitly incentivizes this behavior. Everyone owns a piece of every project directly or indirectly: the Ethereum platform issues tokens that members can exchange for ether and then convert into any other currency. "Our goal is to achieve a nice balance between independence and interdependence," Lubin said. "We view ourselves as a collective of closely collaborating entrepreneurlike agents. At some point, it may prove necessary to suggest that a certain thing really needs to get done and if nobody steps up, to hire someone initially for that role or incentivize internal people to do it," said Lubin. But, overall, "everyone is a self-managed adult. Did I mention we

communicate a lot? Then we all make our own decisions."

The watchwords are *agility*, *openness*, and *consensus*: identify the work to be done, distribute the load among the people eager and able to do it, agree on their roles, responsibilities, and compensation, and then codify these rights in "explicit, detailed, unambiguous, self-enforcing agreements that can serve as the glue to hold all of the business aspects of our relationships together," he said. Some agreements pay for performance, others mete out annual salary in ether, and still others are more like "requests for participation" with bounties attached to task completion such as writing a line of code. If the code passes the test, then the bounty is automatically released. "Everything can be surfaced and appropriately transparent. Incentives are explicit and granular," he said. "This leaves us free to communicate, be creative, and adapt based on these expectations."

Dare we coin the neologism *blockcom,* a company formed and functioning on blockchain technologies? That's the goal, to run as much of ConsenSys as possible on Ethereum, from governance and day-to-day operations to project management, software development and testing, hiring and outsourcing, compensation, and funding. The blockchain also enables reputation systems where members can rate one another's performance as collaborators, thereby syndicating trust in the community. Lubin said, "Persistent digital identity or persona and reputation systems will keep us more honest and well behaved toward one another."

These capabilities blur the boundaries of a company. There are no default settings for incorporation. Members of the ConsenSys ecosystem can form spokes by reaching consensus on strategy, architecture, capital, performance, and governance. They may decide to launch a company that competes within an existing market or provides an infrastructure for a new market. Once it is launched, they can adjust those settings.

Decentralizing the Enterprise

The blockchain will reduce friction for companies everywhere. "Lower friction means lower costs as the price of valuable intermediation is determined via the most efficient price discovery mechanism: decentralized free markets. No longer will incumbents be able to leverage legal, regulatory, informational, and power asymmetries to extract far more value from a transaction in their role as intermediary than they add to it," Lubin said.

Could ConsenSys build some kind of truly decentralized autonomous organization owned and controlled by its nonhuman value creators, governed through smart contracts rather than human agency? "All the way!" said Lubin. "Massive intelligence on a decentralized global computational substrate, an underlying layer, should change the architecture of the firm from a large collection of specialized departments run by humans to software agents that can cooperate and compete in free markets." Some agents will organize for longer periods of time to serve ongoing customer needs, such as utility and maintenance. Others will swarm around a short-term problem, solve it, and dissolve just as quickly, having served their purpose.

Is there a risk that radical decentralization and automation removes human agency in decision making (e.g., the risk of rogue algorithms)? "I am not concerned about machine intelligence. We will evolve with it and for a long time it will be in the service of, or an aspect of, *Homo sapiens cybernetica*. It may evolve beyond us but that is fine," Lubin said. "If so, it will occupy a different ecological niche. It will operate at different speeds and different relevant time scales. In that context, artificial intelligence will not distinguish between humans, a rock, or a geological process. We evolved past lots of species, many of which are doing fine (in their present forms)."

ConsenSys is still a tiny company. Its grand experiment may or may not succeed. But its story provides a glimpse into radical changes in corporate architecture that may help unleash innovation and harness the power of

human capital for not just wealth creation but prosperity. Blockchain technology is enabling new forms of economic organization and new portfolios of value. There are distributed models of the firm emerging—ownership, structure, operations, rewards, and governance—that go far beyond enhancing innovation, employee motivation, and collective action. They may be the long-awaited precondition for a more prosperous and inclusive economy.

Business leaders have another opportunity to rethink how they organize value creation. They could negotiate, contract, and enforce their agreements on the blockchain; deal seamlessly with suppliers, customers, employees, contractors, and autonomous agents; and maintain a fleet of these agents for others to use, and these agents could rent out or license any excess capacity in their value chain.

CHANGING THE BOUNDARIES OF THE FIRM

Throughout the first era of the Internet, management thinkers (Don included) talked up the networked enterprise, the flat corporation, open innovation, and business ecosystems as successors to the hierarchies of industrial power. However, the architecture of the early-twentieth-century corporation remains pretty much intact. Even the big dot-coms adopted a top-down structure with such decision makers as Jeff Bezos, Marissa Mayer, and Mark Zuckerberg. So why would any established firm—particularly ones that make their money off other people's data, operate largely behind closed doors, and suffer surprisingly little in data breach after data breach—want to leverage blockchain technologies to distribute power, increase transparency, respect user privacy and anonymity, and include far more people who can afford far less than those already served?

Transaction Costs and the Structure of the Firm

Let's start with a little economics. In 1995, Don used Nobel Prize–winning economist Ronald Coase's theory of the firm to explain how the Internet would affect the architecture of the corporation. In his 1937 paper "The Nature of the Firm," Coase identified three types of costs in the economy: the costs of search (finding all the right information, people, resources to create something); coordination (getting all these people to work together efficiently); and contracting (negotiating the costs for labor and materials for every activity in production, keeping trade secrets, and policing and enforcing these agreements). He posited that a firm would expand until the cost of performing a transaction inside the firm exceeded the cost of performing the transaction outside the firm.[5]

Don argued that the Internet would reduce a firm's internal transaction costs somewhat; but we thought, because of its global accessibility, it would reduce costs in the overall economy even more, in turn lowering barriers to entry for more people. Yes, it did drop search costs, through browsers and the World Wide Web. It also dropped coordination costs through e-mail, data processing applications like ERP, social networks, and cloud computing. Many companies benefited from outsourcing such units as customer service and accounting. Marketers engaged customers directly, even turning consumers into producers (prosumers). Product planners crowdsourced innovations. Manufacturers leveraged vast supply networks.

However, the surprising reality is that the Internet has had peripheral impact on corporate architecture. The industrial-age hierarchy is pretty much intact as the recognizable foundation of capitalism. Sure, the networks have

enabled companies to outsource to low-cost geographies. But the Internet dropped transaction costs inside the firm as well.

From Hierarchy to Monopoly

So companies today remain hierarchies, and most activities occur within corporate boundaries. Managers still view them as a better model for organizing talent and intangible assets such as brands, intellectual property, knowledge, and culture, as well as for motivating people. Corporate boards still compensate executives and CEOs far beyond any reasonable measure of the value they create. Not incidentally, the industrial complex continues to generate wealth, but not prosperity. In fact, as we have pointed out, there is strong evidence of a growing concentration of power and wealth in conglomerates and even monopolies.

Another Nobel laureate, Oliver Williamson, predicted as much,[6] and pointed out the negative effects on productivity: "Suffice it to observe here that the move from autonomous supply (by the collection of small firms) to unified ownership (in one large firm) is unavoidably attended by changes in both incentive intensity (incentives are weaker in the integrated firm) and administrative controls (controls are more extensive)."[7] Peter Thiel, cofounder of PayPal, wrote in praise of monopolies in his enormously readable and equally controversial book, *Zero to One*. A Rand Paul supporter, Thiel said, "Competition is for losers. . . . Creative monopolies aren't just good for the rest of society; they're powerful engines for making it better."[8]

While Thiel might be right about striving to dominate one's industry or market, he provided no real evidence that monopolies are good for consumers or society as a whole. To the contrary, the entire body of competition law in most democratic capitalist countries derives from a contrary notion. The idea of fair competition dates back to Roman times, with the death penalty for some violations.[9] When firms have no real competition, they can grow as inefficient as they want, raising prices in and outside the firm. Look at governments. Even in the technology industry, many argue that monopolies may help with innovation in the short term but may harm society in the long term. Companies may amass monopoly power through cool products and services that customers love, but the honeymoon eventually ends. It's not so much that their innovations no longer delight; it's that the companies themselves begin to ossify.

Most thinkers understand that innovation typically comes from the edge of the firm, not from its core. Harvard University law professor Yochai Benkler agrees: "Monopolies may have lots of money to invest in R&D but typically not the internal culture of pure and open exploration that is required for innovation. The Web didn't come from monopolies; it came from the edge. Google did not come from Microsoft. Twitter did not come from AT&T, or for that matter even from Facebook."[10] In monopolies, layers of bureaucracy distance the executives at the top from market signals and emergent technology at the edges, where companies bump up against one another and other markets, other industries, other geographies, other intellectual disciplines, other generations. According to John Hagel and John Seely Brown, "The periphery of today's global business environment is where innovation potential is the highest. Ignore it at your peril."[11]

Executives should be excited about blockchain technology, because the wave of innovation coming from the edge may well be unprecedented. From the major cryptocurrencies—Bitcoin, BlackCoin, Dash, Nxt, and Ripple—to the major blockchain platforms—Lighthouse for peer-to-peer crowdfunding, Factom as a distributed registry, Gems for decentralized messaging, MaidSafe for decentralized applications, Storj for a distributed cloud, and Tezos for decentralized voting to name a few—the next era of the Internet has real value attached to it and real incentives to participate. These platforms hold promise for protecting user identity, respecting user privacy and other rights, ensuring

network security, and dropping transaction costs so that even the unbanked can take part.

Unlike incumbent firms, they don't need a brand to convey the trustworthiness of their transactions. By giving away their source code for free, sharing power with everyone on the network, using consensus mechanisms to ensure integrity, and conducting their business openly on the blockchain, they are magnets of hope for the many disillusioned and disenfranchised. As such, blockchain technology offers a credible and effective means not only of cutting out intermediaries, but also of radically lowering transaction costs, turning firms into networks, distributing economic power, and enabling both wealth creation and a more prosperous future.

1. Search Costs—How Do We Find New Talent and New Customers?

How do we find the people and information we need? How do we determine if their services, goods, and capabilities are best for us as we seek to bring the tonic of the market to bear on our internal operations?

Although the architecture of the firm is basically intact, the first era of the Internet dropped such costs significantly and enabled important changes. Outsourcing was really just the beginning. Tapping into ideagoras (open markets for brainpower), companies like Procter & Gamble are finding uniquely qualified minds to innovate a new product or process. In fact, 60 percent of P&G's innovations come from outside the company, by building or harnessing ideagoras like InnoCentive or inno360. Other firms like Goldcorp have created global challenges to search for the best minds to solve their toughest problems. Goldcorp, which published its geological data and talent outside its boundaries, discovered $3.4 billion worth of gold, resulting in a hundredfold increase in the company's market value.

Now imagine the opportunities that arise from the ability to search the World Wide Ledger, a decentralized database of much of the world's structured information. Who sold which discovery to whom? At what price? Who owns this intellectual property? Who is qualified to handle this project? What medical skills does our hospital have on staff? Who performed what type of surgery with what outcomes? How many carbon credits has this company saved? Which suppliers have experience in China? What subcontractors delivered on time and on budget according to their smart contracts? The results of these queries won't be résumés, advertising links, or other pushed content; they'll be transaction histories, proven track records of individuals and enterprises, ranked perhaps by reputation score. Get the picture? Said Vitalik Buterin, founder of the Ethereum blockchain, "Blockchains will drop search costs, causing a kind of decomposition that allows you to have markets of entities that are horizontally segregated and vertically segregated. That never really existed before. Instead you had kind of monoliths that do everything."[12]

Several companies are working on search engines for blockchains, given the potential bonanza. Google's mission is to organize the world's information, so it would make sense for it to assign considerable manpower to investigate this.

There are three key distinctions between Internet search and blockchain search. First is user privacy. While transactions are transparent, people own their personal data and can decide what to do with it. They can participate anonymously or at least pseudonymously (anonymity through a false name) or quasinymously (partial anonymity). Interested parties will be able to search for information that users have made open. Andreas Antonopoulos said, "Transactions are anonymous if you want them to be anonymous. . . . but the blockchain enables radical transparency a lot easier than it enables radical anonymity."[13]

Many firms will need to rethink and redesign the recruiting process. For example, human resources or personnel staff will need to learn how to query

the blockchain with yes/no questions: Are you a human being? Have you earned a PhD in applied mathematics? Can you code in Scrypt, Python, Java, C++? Are you available to work full time from January through June next year? And other qualifications. These queries will scurry about the black boxes of people on the job market and yield a list of people who meet these qualifications. They could also pay prospective talent to place pertinent professional information on a blockchain platform where they can sort through it. HR staff must master the use of reputation systems, moving forward with candidates without knowing anything irrelevant to the job, such as age, gender, race, country of origin. They also need search engines that can navigate various degrees of openness, from fully private to fully public information. The upside is an end to subconscious or even institutional bias and headhunter or executive recruiting fees. The downside is that precise queries lead to precise results. There is less possibility of serendipity, the discovery of a candidate who lacks the qualifications but has great capacity to learn and to make the random creative connections that a firm desperately needs.

Ditto for marketing. Firms may have to pay just to query a prospective customer's black box, to see whether that customer meets a firm's target audience. That customer may decide globally to withhold certain data such as gender, because a no answer is still valuable. But in so doing, the firm will learn nothing more about the prospect beyond the yes/no results of the query. Chief marketing officers and marketing agencies will need to rethink any strategy based on e-mail, social media, and mobile marketing: where the infrastructure may lower communications costs to zero, customers will raise costs to a figure that makes reading a firm's message worth their while. In other words, you'll be paying customers to listen to your elevator pitch, but you will have tailored your query to pitch only to a sharply defined audience so that you will be reaching exactly the people you want to reach without invading their privacy. You can test different queries to learn about different microniches at every stage of new product development. Let's call it *black box marketing*.

The second distinction is that search can be multidimensional. When you search the World Wide Web today, you search a snapshot in time, as indexed over the last several weeks.[14] Computer theorist Antonopoulos called this two-dimensional search: *horizontal*, a wide search across the Web, and *vertical*, a deep search of a particular Web site. The third dimension is *sequence*, to see these in the order of uploading over time. "The blockchain can add the additional dimension of time," he said. The opportunity to search a complete record of everything that ever happened in three dimensions is profound. To make his point, Antonopoulos searched the bitcoin blockchain to find its famous first commercial transaction, the purchase of two pizzas done by someone named "Laslo" for 10,000 bitcoins. "The blockchain provides an almost archaeological record, a deep find, preserving information forever." (To save you from doing the math, if the pizza costs $5 when $1 was equal to 2,500 bitcoins, that would be worth $3.5 million as of the writing of this book . . . but we digress.)

For firms, this means a need for better judgment: managers need to hire people who have demonstrated good judgment, because there's no walking back poor decisions, no spinning the order of events, no denying an executive's disreputable behavior. For really important decisions, firms could implement internal consensus mechanisms whereby all stakeholders vote on mission-critical decisions to end the chorus of ignorance and denial of prior knowledge. Or use prediction markets to test scenarios. If you're an executive of a future Enron, no scapegoating. As for New Jersey governor Chris Christie, good luck telling a prosecutor that you knew nothing of plans to close the George Washington Bridge.

The third distinction is value: where information on the Internet is abundant, unreliable, and perishable, it is scarce, tamperproof, and permanent on the blockchain. To this last characteristic, Antonopoulos notes:

"If there is enough financial incentive to preserve this blockchain into the future, the possibility of it existing for tens, hundreds, or even thousands of years cannot be discounted."

What an amazing concept. The blockchain as part of the archaeological record, like the original stone tablets of Mesopotamia. Paper records are ephemeral and temporary, whereas (ironically) the oldest form of recording information, tablets, is the most permanent. The implications for corporate architecture are considerable. Imagine a permanent, searchable record of important historical information, like the history of finance. Corporate staff responsible for developing financial statements, annual reports, reports to governments or donors, marketing materials for prospective employees, clients, and consumers—will start with this public, indisputable view of their firm, maybe even creating a filter that enables stakeholders to see what they see at the press of a button. Companies could have transaction ticker tapes and dashboards, some for internal managerial use and some public. Rest assured: All your competitors will construct such feeds and dashboards of your firm as part of their competitive intelligence programs. So why not put those on your Web site and draw everyone to you?

This provides enormous incentive for firms to look for resources outside their boundaries, as they have almost infinitely better information about the qualities and record of candidates, be they individuals or companies.

Companies like ConsenSys are developing identity systems where job prospects or prospective contractors will program their own personal avatars to disclose pertinent information to employers. They can't be hacked like a centralized database can. Users are motivated to contribute information to their own avatars because they own and control them, their privacy is completely configurable, and they can monetize their own data. This is very different from, say, LinkedIn, a central database owned, monetized, and yet not entirely secured by a powerful corporation.

Could Coase and Williamson have imagined a platform that could drop search costs so that firms could find capability outside their boundaries that cost less and could perform better?

2. Contracting Costs—What Do We Agree to Do, Anyway?

How do we come to terms with other parties or enter into an agreement? It's one thing to lower the costs of finding people and resources that can do the job. But that's not enough to shrink a firm significantly. All parties must agree to work together. The second reason why we have firms is contractual costs, such as negotiating the price, establishing capacity, and spelling out the conditions of a supplier's goods or services; policing them and enforcing the terms; and handling remedies if parties don't deliver as promised.

We've always had social contracts, understandings of relationships in the specialization of roles where some people in the tribe hunted and protected the tribe, and others gathered and sheltered the tribe. People have traded physical objects in real time since the dawn of modern man. Contracts are a more recent phenomenon, as we began trading promises, not property. Oral agreements proved easily manipulated or misremembered, and eyewitnesses were unreliable. Doubt and distrust tempered collaboration with strangers. Contracts had to be fulfilled immediately, and there were no formal mechanisms for enforcement of the terms beyond what you could take by force. The written contract was a way of codifying an obligation, of establishing trust and setting expectations. Written contracts provided guidance when someone did not hold up his end of the bargain, or something unexpected happened. But they couldn't exist in a vacuum; there had to be some legal framework that recognized contracts and enforced each party's rights.

Today contracts are still made of atoms (paper), not bits (software). As such they have huge limitations, serving to simply document an agreement. As

we shall see, if contracts were software—smart and distributed on the blockchain—they could open a world of possibilities, not the least of which is to make it easier for companies to collaborate with external resources. And just imagine how the Uniform Commercial Code might look on the blockchain.

Coase and his successors argued that contracting costs are lower inside the boundaries of firms rather than outside in the market—that a firm is essentially a vehicle for creating long-term contracts when short-term contracts are too much effort.

Williamson advanced this idea by arguing that firms exist to resolve conflicts, largely through making contracts with various parties inside the firm. In the open market, the only dispute mechanism is the court—costly, timely, and often unsatisfactory. Further, he argued that in some cases like fraud, other illegal acts, or conflict of interest, there is no market dispute mechanism at all. "In effect, the contract law of internal organization is that of forbearance, according to which a firm becomes its own court of ultimate appeal. Firms, for this reason, are able to exercise fiat that the markets cannot."[15] Williamson conceived of the firm as "a governance structure" for contractual arrangements. He said that organizational structure matters in reducing the costs of managing transactions and that "recourse to the lens of contract, as against the lens of choice, frequently deepens our understanding of complex economic organization."[16] This is a recurring theme in management theory, perhaps most powerfully explained by economists Michael Jensen and William Meckling. They argued that entities are nothing more than a collection of contracts and relationships.[17]

Today, some erudite blockchain thinkers have picked up on this view. Ethereum inventor Vitalik Buterin argues that corporate agents (i.e., executives) could use corporate assets only for certain purposes approved by, say, a board of directors, who in turn are subject to shareholder approval. "If a corporation does something, it's because its board of directors has agreed that it should be done. If a corporation hires employees, it means that the employees are agreeing to provide services to the corporation's customers under a particular set of rules, particularly involving payment," Buterin wrote. "When a corporation has limited liability, it means that specific people have been granted extra privileges to act with reduced fear of legal prosecution by the government—a group of people with more rights than ordinary people acting alone, but ultimately people nonetheless. In any case, it's nothing more than people and contracts all the way down."[18]

That's why the blockchain, by reducing contracting costs, enables firms to open up and develop new relationships outside their boundaries. ConsenSys, for example, can architect complex relationships with a diverse set of members, some inside its boundaries, some outside, and some straddling walls, because smart contracts govern these relationships rather than traditional managers. Members self-assign to projects, define agreed-upon deliverables, and get paid when they deliver—all on the blockchain.

Smart Contracts

The rate of change is increasingly setting the stage for smart contracts. More people are developing not only computer literacy, but also fluency. As far as evidencing transactions goes, this new digital medium has significantly different properties from its paper predecessors. As cryptographer Nick Szabo highlighted, not only can they capture a greater array of information (such as nonlinguistic sensory data) but they are dynamic: they can transmit information and execute certain kinds of decisions. In Szabo's words, "Digital media can perform calculations, directly operate machinery, and work through some kinds of reasoning much more efficiently than humans."[19]

For the purposes of this discussion, smart contracts are computer programs that secure, enforce, and execute settlement of recorded agreements between people and organizations. As such, they assist in negotiating and

defining these agreements. Szabo coined the phrase in 1994, the same year that Netscape, the first Web browser, hit the market:

> A smart contract is a computerized transaction protocol that executes the terms of a contract. The general objectives of smart contract design are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitration and enforcement costs, and other transaction costs.[20]

Back then, smart contracts were an idea all dressed up with nowhere to go, as no available technology could deploy them as Szabo described. There were computer systems such as electronic data interchange (EDI) that provided standards for the communication of structured data between the computers of buyers and sellers, but no technology that could actually trigger payments and cause money to be exchanged.

Bitcoin and the blockchain changed all that. Now parties can make agreements and automatically exchange bitcoin when they meet the terms of the agreement. Most simply, your brother-in-law can't weasel out of a hockey bet. Less simply, when you purchase a stock, the trade settles instantly and the shares are immediately transferred to you. Even less simple, when contractors deliver the software code that meets the necessary specifications, they get paid.

The technological means of executing limited smart contracts has existed for some time. A contract is a bargained-for exchange enforceable before the exchange. Andreas Antonopoulos explained with a simple example: "So if you and I were to agree right now that I would pay you fifty dollars for the pen on your desk, that's a perfectly enforceable contract. We can just say, 'I promise to pay you fifty dollars for the pen on your desk,' and you would respond, 'Yes, I would like that.' That turns out to be 'offer acceptance and consideration.' We've got a deal, and it can be enforced in a court. That has nothing to do with the technological means of implementation of the promises that we have made."

What interests Andreas about the blockchain is that we can execute this financial obligation in a decentralized technological environment with a built-in settlement system. "That's really cool," he said, "because I could actually pay you for the pen right now, you would see the money instantly, you would put the pen in the mail, and I could get a verification of that. It's much more likely that we can do business."

The law profession is slowly plugging into this opportunity. Like everyone in the middle, lawyers may become subject to disintermediation and will eventually need to adapt. Expertise in smart contracts could be a big opportunity for law firms that want to lead innovation in contract law. However, the profession isn't known for breaking new ground. Legal expert Aaron Wright, coauthor of a new book about the blockchain, told us, "Lawyers are laggards."[21]

Multisignature: Smart Complex Contracts

But, you say, wouldn't the costs of complex and time-consuming negotiations of smart contracts outweigh the benefits of open boundaries? The answer at this point appears to be no. If partners spend more time up front determining the terms of an agreement, the monitoring, enforcement, and settlement costs drop significantly, perhaps to zero. Further, settlement can occur in real time, possibly in microseconds throughout the day depending on the deal. Most

important, by partnering with superior talent, companies can achieve better innovation and become more competitive.

Let's consider the use of independent contractors. In the early days of digital trade, the blockchain accommodated only the simplest two-party transactions. For instance, if Alice needed someone to complete a piece of code quickly, she would post an anonymous "coder needed" request on an appropriate discussion board. Bob would see it.[22] If the price and timing were right, he would send work samples. If his samples met Alice's needs, then she made Bob an offer. They agreed on terms: Alice would send half the fee immediately and half upon receipt of completion and successful test of the code.

Their contract was straightforward—an offer to hire and an acceptance to do the job, and it needn't have been in writing, though their interactions on the blockchain made it so. Their ownership of bitcoins was associated with digital addresses (long strings of numbers) that had two components: a public key that served as an address, and a private key that gave its owner exclusive access to any coins associated with that address. Bob sent Alice his public key, and she directed the first payment there. The network recorded the transfer and associated those bitcoins to Bob's public key wallet.

What if, at this point, Bob decided that he didn't want to do the project? In this two-party transaction, Alice would have little recourse. She couldn't go to her credit card company to reverse the transaction. She couldn't (yet) go to civil court and sue Bob for breach of contract. Beyond a randomly generated alphanumeric code and an online advertisement, she would have no way of identifying Bob unless he'd posted his ad on a centralized platform that could track Bob down, or they'd exchanged e-mails through a centralized service. She could, however, indicate that his public key was not to be trusted, thus lowering his reputation score as a coder.

Without assurances of the other party's trustworthiness in fulfilling off-chain actions, the deal was a prisoner's dilemma of sorts: it still required some trust. Reputation systems could mitigate this uncertainty to some extent. But we needed to introduce trust and security into this anonymous and open system.

In 2012, "core developer" Gavin Andresen introduced a new type of bitcoin address to the bitcoin protocols called "pay to script hash" (P2SH). Its purpose was to allow one party "to fund any arbitrary transaction, no matter how complicated."[23] Parties use multiple authenticating signatures or keys rather than a single private key to complete a transaction. The community usually refers to this multiple-signature feature as simply "multisig."

In a multisig transaction, parties agree on the total number of keys generated (N) and how many will be required to complete a transaction (M). This is called an M-of-N signature scheme or security protocol. Think of a lockbox requiring multiple physical keys to open. With this feature, Bob and Alice would agree in advance to employ a neutral, disinterested third-party arbitrator to help them complete their transaction. Each of the three parties would hold one of three private keys, two of which are needed to access the transferred funds. Alice would send her bitcoin to a public address. At this point, those funds can be viewed by anyone, but accessed by no one. Once Bob sees the funds have been posted, he fulfills his end of the bargain. If, upon receipt of Bob's good or service, Alice is unsatisfied and feels cheated, she could refuse to provide Bob with the second key. The two parties would then look to the arbitrator, holder of the third key, to help them resolve their disagreement. The intervention of such arbitrators is called for only in cases of disputes like these, and at no point do they themselves have access to the funds—a mechanism enabling the rise of "smart contracts."

To contract remotely, let alone automatically, you need a certain degree of trust that the system will enforce your rights under the deal. If you can't trust the other party, you have to trust the dispute resolution mechanisms and/or legal system behind it. Multisig technology allows these deliberately disinterested third parties to bring security and trust to anonymous

transactions.

Multisig authentication is growing in popularity. A start-up called Hedgy is using multisig technology to create futures contracts: parties agree on a price of bitcoin that will be traded in the future, only ever exchanging the price difference. Hedgy never holds collateral. The parties place it in a multisig wallet until the execution date. Hedgy's goal is to use multisig as a foundation for smart contracts that are completely self-executable and fully evidenced on the blockchain.[24] Think of the blockchain as a dialectic between anonymity and openness, where the multisig feature reconciles the two without loss of either.

Among other things, the smart contract changes the role of those within firms who are in the business of finding and contracting for talent. HR departments need to understand that talent is outside their boundaries, not just inside. They need to step up to the challenges of using smart contracts to lower the costs of building relationships with external resources.

3. Coordination Costs—How Should We All Work Together?

So we've found the right people and you've contracted with them. How do you manage them? Throughout his writings, Coase discussed costs of coordinating, meshing, or otherwise orchestrating the different people, products, and processes into an enterprise that can effectively create value. Against traditional economists who argued that there were internal markets within firms, Coase said that when "a workman moves from department Y to department X, he does not go because of a change in relative prices, but because he is ordered to do so."[25] In other words, markets allocate resources via the price mechanism, but firms allocate resources via authoritative direction.

Williamson went on to explain that there are two significant coordinating systems. First is the price system for decentralized resource allocation needs and opportunities (the market). But second, (traditional) "firms employ a different organizing principle—that of hierarchy—whereupon authority is used to affect resource allocation." Over the last few decades, hierarchies have come under scrutiny as structures for killing creativity, undermining initiative, disempowering human capital, and scapegoating responsibility through opacity. To be sure, many management hierarchies have become unproductive bureaucracies. However, hierarchy as a concept has gotten a bad rap, as has its most eloquent defender, Canadian-born psychologist Elliot Jaques. In a classic 1990 *Harvard Business Review* article, Jaques argued, "35 years of research have convinced me that managerial hierarchy is the most efficient, the hardiest, and in fact the most natural structure ever devised for large organizations. Properly structured, hierarchy can release energy and creativity, rationalize productivity, and actually improve morale."[26]

The trouble is that, in recent business history, many hierarchies have not been effective, to the point of ridicule. Exhibit A is *The Dilbert Principle*, most likely one of the best-selling management books of all time, by Scott Adams. Here's Dilbert on blockchain technology from a recent cartoon:

> Manager: I think we should build a blockchain.
> Dilbert: Uh-oh. Does he understand what he said or is it something he saw in a trade magazine ad?
> Dilbert: What color do you want your blockchain?
> Manager: I think mauve has the most RAM.

In the cartoon, Adams captures one of the marks of hierarchies gone wrong—that managers often rise to a level of power where they lack the knowledge required for effective leadership.

Combined with progressive management thinking about how to build

effective, innovative organizations, the first generation of the Internet enabled progressive thinking managers to change the top-down assignment of work and appropriation of credit, recognition, and promotion.

For better or for worse, centralized hierarchies are the norm. Decentralization, networking, and empowerment have been sensible since the early days of the Internet. Teams and projects have become the foundation of internal organization. E-mail enabled people to collaborate across organizational silos. Social media dropped some collaboration costs internally and dropped transaction costs and made the boundaries of corporations more porous as companies could link up with suppliers, customers, and partners more easily.

However, today's commercial social media tools are helping many firms achieve new levels of internal collaboration. Empowerment, the real decentralization of power, is an important focus in business; and companies have experimented or implemented new concepts ranging from matrix management to holacracy—with varying degrees of success.

In fact, there is widespread agreement that when firms distribute responsibility, authority, and power, the result will typically be positive: better business function, customer service, and innovation. But this practice is easier said than done.

The Internet also hasn't dropped what economists call "agency costs"—the cost of making sure that everybody inside the firm is acting in the owner's interest. In fact, another Nobel Prize–winning economist (yes, there do seem to be a lot of them in this story), Joseph Stiglitz, argued that the sheer size and seeming complexity of these firms have increased agency costs even as a firm's transaction costs have plummeted. Hence, the huge pay gap between CEO and front line.

So where does blockchain technology come in and how can it change how firms are managed and coordinated internally? With smart contracts and unprecedented transparency, the blockchain should not only reduce transaction costs inside and outside of the firm, but it should also dramatically reduce agency costs at all levels of management. These changes will in turn make it harder to game the system. So firms could go beyond transaction cost to tackle the elephant in the boardroom—agency cost. Yochai Benkler told us, "What's exciting to me about blockchain technology is that it can enable people to function together with the persistence and stability of an organization, but without the hierarchy."[27]

It also suggests that managers should brace themselves for radical transparency in how they do coordinate and conduct themselves because shareholders will now be able to see the inefficiencies, the unnecessary complexity, and the huge gap between executive pay and the value executives actually contribute. Remember, managers aren't agents of owners; they're intermediaries.

4. Costs of (Re-)Building Trust—Why Should We Trust One Another?

As we have explained, trust in business and society is the expectation that another party will be honest, considerate, accountable, and transparent—that he or she will act with integrity.[28] It's a lot of work to establish trust, and many economists and other academics argue that we have vertically integrated firms because establishing trust is easier within corporate boundaries than in an open market. With trust at an all-time low, the challenge for firms is not simply figuring out whom to trust, but how to get outside capability to trust them.

Indeed, economist Michael Jensen and colleagues made the case that *integrity* is a factor of production. Not the first but among the most eloquent on the topic, they explain that the seemingly never-ending scandals in the world of finance with their damaging effects on value and human welfare argue strongly for the addition of integrity to financial operations. To them

this is not an issue of virtue, but an opportunity in financial economics to "create significant increases in economic efficiency, productivity, and aggregate human welfare." To them, "Integrity . . . on the part of individuals or organizations has enormous economic implications (for value, productivity, quality of life, etc.). Indeed, integrity is a factor of production as important as labor, capital, and technology."[29]

Wall Street lost trust (and nearly killed capitalism) because of a set of integrity violations. But has it changed? And will it change? In the past, corporate social responsibility advocates argued that companies "do well by doing good." We haven't seen the evidence. Many companies *did well by doing bad*—by having bad labor practices in the developing world, by externalizing their costs onto society such as pollution, by being monopolies and gouging customers. The collapse of 2008 taught us for sure that companies "do badly by being bad." The major banks found this out the hard way. Prior to 2008 many were making upwards of 20 percent return on equity. For many today it is well below 5 percent, with some not even making their cost of capital. From a shareholder perspective, they should no longer exist.[30]

What are the chances, realistically, that Wall Street will wake up to Jensen's exhortations and act with integrity? Surely, expedience and short-term gain are coded into the DNA of the Western financial system.

Enter blockchain technology and digital currencies. What if parties didn't have to trust one another, but could still act with honesty, accountability, consideration, and transparency because it was the foundation of the technological platform of finance?

Steve Omohundro gave us a compelling example. "If somebody from Nigeria wants to buy something that I'm selling, I'm going to be very skeptical, I'm not going to accept a credit card or a check from Nigeria. With the new platform, I know I can trust it and I don't have to incur the costs of establishing trust. So it enables transactions which simply couldn't happen otherwise."[31]

So Wall Street banks don't have to splice integrity into their DNA and behavior; the founders of blockchains have coded it into their software protocols and deployed it across the network—enabling a new utility for the financial services industry. The good news is that the industry can reestablish trust and maintain it in an ongoing way.

With blockchain technology causing the costs of searching, contracting, coordinating, and creating trust to plummet, it should be easier for firms not just to open up, but also to forge trusting relationships with external parties. Acting in one's self-interest serves everybody's interests. Cheating the system costs more than using it as designed.

This is not to say that corporate brands or for that matter acting ethically is unimportant or no longer required. Blockchain helps ensure integrity and therefore trust in transactions between peers. It also helps achieve transparency—a critical factor in trust. However, as author and technology theorist David Ticoll says: "Trust and brand are about more than vouchsafing a transaction. They are also about quality, enjoyment, safety of a device or service, cachet and coolness. In today's COP21 world, the best brands transparently and verifiably signify outcomes that are environmentally, socially, and economically responsible."[32]

Still, through smart contracts, executives can be held accountable—they must abide by their commitments as enforced and settled by software. Companies can program relationships with radical transparency so everyone has a better understanding about what each party has signed up to do. And overall, like it or not, they must conduct business in a way that is considerate of the interests of other parties. The platform demands it.

DETERMINING CORPORATE BOUNDARIES

Overall, the boundaries that separate a company from its vendors, consultants, customers, external peer communities, and others will become harder to define. Perhaps as important, they will constantly change.

Firms will still exist, blockchain notwithstanding, because the mechanisms for searching, contracting, coordinating, and establishing trust within corporate boundaries will be more cost-effective than those in the open market, at least for many activities. The idea of the so-called free agent nation, where individuals execute work outside the boundaries of corporations, is illusory. Melanie Swan, who founded the Institute for Blockchain Studies, said, "What's the right size of the corporation for optimal transactibility? Well, it's not a unitary thing, of people working only as individuals or e-lancers." To her, there will be new kinds of "flexible business entities of individuals and groups partnering around projects." She views the new model of the firm more like the guild, the preindustrial associations of merchants or tradesmen who worked together in a particular town. "We still need organizations acting as coordinating mechanisms. But the new models of team collaboration are not yet fully clear."[33]

Today we often hear that firms should focus on their core. But when considering how blockchain technology drops transaction costs, what is core? And how do you define that when a company's core is constantly changing?

It seems that everyone has a different definition of what the optimal firm size should be to maximize productivity and competitive advantage. Many firms we examined didn't have a clear view, seeming to choose the Bob Dylan approach to determining what's in and what should be out ("You don't need a weatherman to know which way the wind blows"). Back-office processing, for example, was described as a no-brainer, without any clear criteria as to why.

Some are more rigorous. From the core competencies view developed by Gary Hamel and C. K. Prahalad, firms gain competitive advantage through competence mastery. Those competencies mastered are central to the firm, while others can be acquired from outside.[34] However, a firm may have mastery over some activities that are not mission critical. Should they still be kept inside?

Strategist Michael Porter has an implicit view that competitive advantage stems from activities, in particular from networks of reinforcing activities that are hard to replicate in their totality. It's not the individual parts of the business that matter, but how they are strung together and built to reinforce one another in a unique activity system. Competitive advantage comes from the entire system of activities; while any individual activity within the system may be copied, competitors cannot produce the same benefit unless they manage to duplicate the entire system.[35]

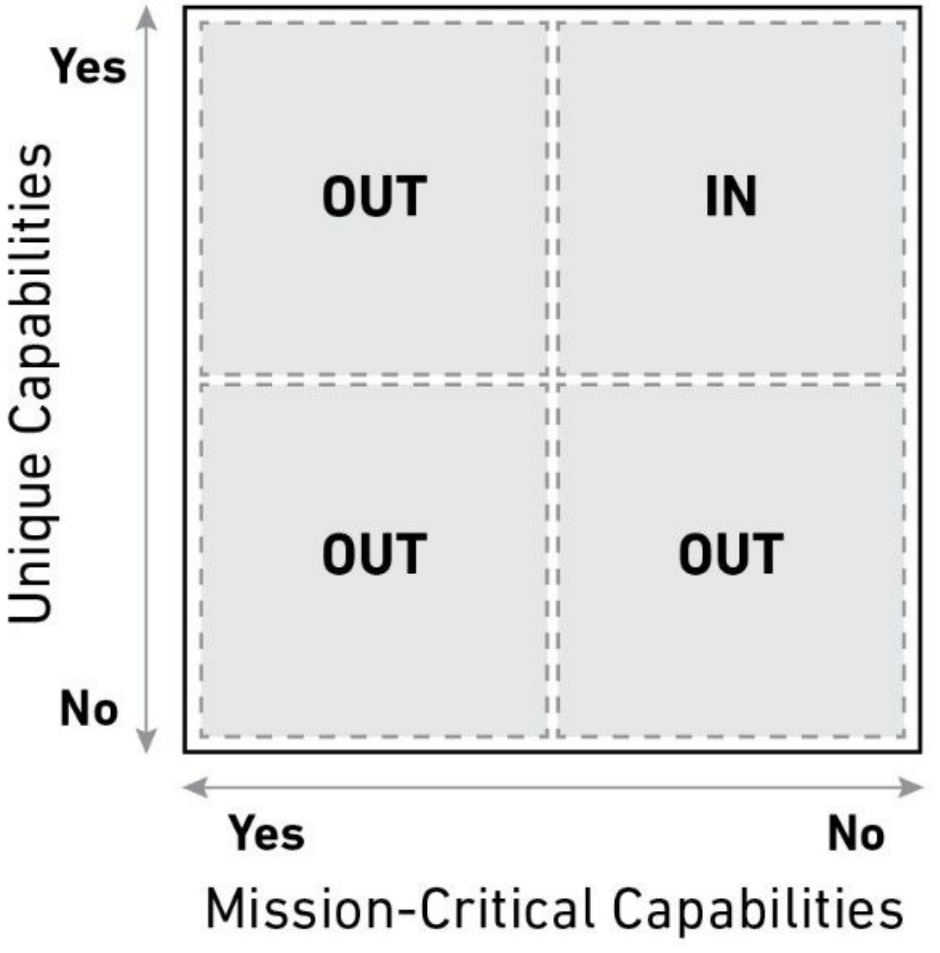
Others argue that companies should always retain functions or capabilities that are mission critical—those that firms must absolutely get right for survival and success. But making computers is mission critical for computer companies; yet Dell, HP, and IBM outsource much of this activity to electronics manufacturing services companies like Celestica, Flextronics, or Jabil. Final assembly of vehicles is mission critical for an auto manufacturer; yet BMW and Mercedes contract with Magna to do this activity.

Stanford Graduate School of Business professor Susan Athey argues persuasively: "There may be some mission-critical functions, like the collection and analysis of big data, that are just too risky to move outside corporate boundaries, even if you don't have unique abilities in that area."[36] True, there may be some functions like data analytics where survival depends on being uniquely good, and there may be existential risks of partnering. Still, external resources can be deployed strategically to build internal capability.

Our view is that the starting point for corporate boundary decisions is to understand your industry, competitors, and opportunities for profitable growth—and use this knowledge as the basis for developing a business strategy. From there, the blockchain opens up new opportunities for networking that every manager and knowledge worker needs to consider at all times. Boundary choices are not simply for senior executives, they are for anyone who cares about marshaling the best capability for innovation and high performance. We should add—and this is no small point—that you can't outsource your corporate culture.

Enter the Matrix

Taking into account how blockchain technology can enable access to unique capabilities outside corporate boundaries, firms can now define those business activities or functions that are fundamental to competitiveness—that are both mission critical and also unique enough to ensure differentiated value.



However, this In-Out Matrix is just a starting point for defining corporate boundaries at any given point. What other factors should firms consider in determining what is fundamental? What extenuating circumstances are there that might affect choices to outsource or nurture internally?

Hacking Your Future: Boundary Decisions

When making boundary choices, firms should start using the blockchain to marshal a 360-degree view and reach consensus on what is unique and what is mission critical in their business. Let's return to Joe Lubin and ConsenSys, as they foreshadow the modus operandi of the blockchain-based enterprise. Remember that ConsenSys is in its infancy, and much can go wrong to undermine its business. We can still learn from this company's example.

1. Are there possible partners who could do the work better? In particular, could we benefit from harnessing new peer production communities, ideagoras, open platforms, and other blockchain business models? The company ConsenSys is able to orchestrate extraordinary expertise to do its work, even though many are outside its boundaries.

2. Given blockchain technology, what are the new economics of corporate boundaries—the transaction costs of partnering, versus keeping/developing in-house? Can you develop a suite of smart contracts whose core elements are modular and reusable? ConsenSys uses smart contracts to reduce coordination costs.

3. What is the extent of technological interdependence versus modularity? If you can define business components that are modular, then you can easily reconfigure them outside corporate boundaries. ConsenSys sets standards for software development and provides access to various software modules that its partners can build upon.

4. What are your firm's competencies with regard to the managing of outsourced work? Can smart contracts enhance those competencies and lower costs? From the get-go, ConsenSys was a blockchain business. CEO Joe Lubin embraces the technology and a modified holacracy, and we can see the seven design principles at work.

5. What are the risks of opportunism where a partner might encroach on fundamental parts of your business, as some have suggested Foxconn may do to smart phone companies? ConsenSys tries to mitigate this challenge by building loyalty through incentive structures whereby its talent shares in the wealth they create.

6. Are there legal, regulatory, or political obstacles to deeper networking (and shrinking) of the organization? Not a problem for ConsenSys yet.

7. Speed and pace of innovation are important to boundary decisions. Sometimes firms have no choice but to partner for a strategic function because they cannot develop it in-house fast enough. A partner arrangement can be a placeholder. Will partnering help us build an ecosystem that will improve our competitive advantage? This is ConsenSys's strategy: build a network of collaborators around the Ethereum platform, grow the platform and ecosystem, and increase the probability of success for all components.

8. Is there a danger of losing control of something fundamental—for example, a product or network architecture? Firms must have a sense of which parts of the value chain will be key to creating

and capturing value in the future. If these are farmed out, the firm will lose. The Ethereum platform provides a basic architecture for ConsenSys.

9. Is there a capability, like the exploitation of data assets, that must be part of the fabric of your enterprise and all its operations? Even though you lack a unique capability, you should view partnering as a transitional tactic to develop extraordinary internal expertise and capacity. Blockchain technologies will introduce a new set of capacities that need to reside in the cranium of every employee. You can't move culture outside your boundaries.