UNUM

The Blockchain for Distributed Manufacturing

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By Dana Martens
With Audrey Fox

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ALL DESIGNS FABRICATED AT
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About the Author

Dana Martens is a designer, creative technologist, maker, teacher, student and geek currently studying design and technology at Parsons School of Design.

She comes from a background designing sustainable community development practices and supporting NYC small businesses, now pursuing new skills that will help her connect her dual passions of building new technologies and designing community-led impact projects in order to better develop unique and sustainable approaches to social innovation, entrepreneurship, and meaningful policy in urban environments.

Dana most recently worked as a Policy Associate at The New York Academy of Medicine where she developed policy and supported a portfolio of work at the intersection of aging, business, entrepreneurship, and technology, as well as leading the Age-friendly Local Business Initiative - where she designed internationally recognized age-friendly design guidelines for small businesses, now published citywide in several languages.

Previously, she worked for The New York City Department of Small Business Service's NYC Business Solutions center where she taught aspiring entrepreneurs to start, operate, and expand their businesses by cutting through red tape, navigating permits and licensing challenges, direct mentoring, and instructing classes in the Small Business Digital Toolkit series.

Dana holds a bachelor of arts cum laude in Economics from Smith College and is a Candidate in the Master of Fine Arts Design + Technology Program at Parsons School for Design.

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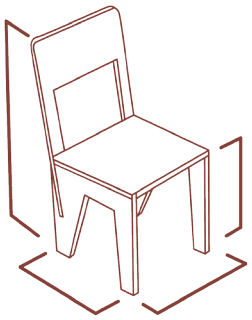


Abstract

The Future Is Here - Let's Distribute It

The Maker Movement is already redefining labor and capital relationships for the 21st century. Fueled by the proliferation of affordable digital design and fabrication tools, this movement is democratizing production and decentralizing manufacturing, giving many the ability to craft and sell their own products. However, no viable system yet exists to coordinate manufacturing relationships in a truly distributed network.

Unum harnesses the blockchain protocol to do just this, bringing designers and makers together in trusted collaborations and connecting global ideas to local on-demand production that is centered around customers. Unum envisions a future where home goods, furniture, art, and electronics are all created through distributed manufacturing channels, supporting more sustainable, transparent, and community-driven production. The blockchain makes this future real community-driven production. The blockchain makes this future real.

Project Overview

Concept, Design, Impetus

Concept

"...it is easier to imagine the end of the world than to imagine the end of capitalism."
Frederic Jameson

I AM EXPLORING HOW EMERGING TECHNOLOGY CAN FURTHER THE LEGACY OF DECENTRALIZATION FIRST BEGAN BY THE INTERNET REVOLUTION.

By analyzing how new digital design and fabrication tools and the blockchain protocol continue this historical trajectory, I seek to understand how their intersection can empower individuals to collaboratively design, fabricate and exchange goods and value in trusted peer-to-peer networks. I hope to use this framework to reimagine traditional systemic relationships between producers/consumers and labor/capital, finally breaking out of a fatalistic dependency on capitalism as the only real economic future.

While this may seem speculative in nature, the truth is that (in the words of William Gibson) this future is already here, it just isn't yet widely distributed. Unum makes this exploration real, proposing a proof-of-concept platform to coordinate distributed manufacturing using the blockchain protocol. Unum connects designers, makers, and customers in trusted peer-to-peer collaborative relationships, without the need for intermediaries, allowing for globally sourced digital designs to be produced anywhere, while ensuring all parties are paid for their unique contribution. What is truly revolutionary is that Unum could be built today and irreparably disrupt the manufacturing industry if taken to scale.

Given the pace and fervor of both the Maker Movement and 'Blockchain Revolution', it is critically necessary to build an effective framework and ruleset for a future based on the distributed manufacturing relationships already beginning today. By harnessing the blockchain to coordinate on-demand production through a decentralized network of makerspaces, Unum drives sustainable, transparent, and community-driven production that supports local economies. Through this project, I hope to concretely illustrate how the decentralizing potential of technology can be made manifest in practice, enabling people to imagine more collaborative and equitable economic paradigms for our connected future.

Design

Design Statement & Design Questions

THE MAKER MOVEMENT IS ALREADY REDEFINING LABOR AND CAPITAL RELATIONSHIPS FOR THE 21ST CENTURY.

Its power to democratize production and decentralize manufacturing is made possible by the recent proliferation of digital design and fabrication tools, allowing almost anyone with a computer to craft and sell their own products. However, no system yet exists to connect stakeholders in truly distributed manufacturing network. Unum solves for this problem by harnessing the blockchain protocol to bring designers and makers together in trusted collaborations, connecting global ideas to local on-demand production that is centered around customers.

Unum envisions a future where most home-goods, furniture, art and similar products are created through distributed manufacturing channels, supporting more sustainable, transparent, and community-driven production.

Design Questions

When beginning the design process, I developed the following questions to better understand how the blockchain could support the increase in local manufacturing enabled by the maker movement. These questions were essential in testing assumptions about what challenges the blockchain can/cannot solve for, what new business opportunities it can create, and what new economic relationships it can engender.

Digital Fabrication & Making

- How might we connect designers, makers, and customers together in new business arrangements that prioritize global ideas produced by local fabrication?
- How might we solve for the issue of double-spending found in online assets when creating a copy of a physical good based on a digital idea?
- How might we verify that physical copies of digital ideas are licensed productions and/or verified builds?
- How might we help people to reimagine value and exchange as digital fabrication increasingly allows physical products to quickly and easily be made from digital ideas?
- How might we harness technology's power to decentralize information to equally decentralize manufacturing processes?
- How might we build an infrastructure that allows a distributed network of local makerpaces to produce globally-sourced designs on demand?

The Blockchain Protocol

- How might we leverage the security, transparency, immutability, and auditability of applications run on the blockchain protocol to reimagine manufacturing relationships?
- How might we determine the provenance and digital manufacturing thread of a product's lifecycle using the blockchain protocol?
- How might we embed NFC/RFID sensors in physical product so that it is possible to use a smartphone or computer to check its digital origin and production history?

Final Forms

Final Deliverable, Audience & Context

Final Deliverable

Unum is a speculative system-level design articulated as a real business proposition. Early thesis research showed that while speculative and critical design practice is great for helping people imagine and interact with alternate futures, it is not effective if based on emerging technology that most don't yet understand and can't imagine as a result. Since the blockchain protocol is still quite unknown and untested, deep research into its real-world possibilities and potential to support other types of new technology was required to truly articulate how revolutionary it could be if implemented across different industries.

In order to demonstrate this potential, Unum is a real business proposition that leverages the strengths of the blockchain protocol - trusted collaboration between one or more parties online, without an intermediary, to solve for key issues in current attempts to decentralize industrial labor/capital relationships through the emergence of the cheap, accessible, and easy-to-use digital design and fabrication tools that have driven the recent Maker Movement and are touted as being harbingers of the 'Third Industrial Revolution'.

Unum is designed with several audiences in mind, with several final forms that explain its potential for different stakeholders. The Unum white paper is written for a more academic audience, articulating the potential of blockchain technology to support a true decentralization of labor/capital relationships and explore how a more distributed economic system could work, using manufacturing as a case study. Unum is also a proof-of-concept startup articulated through an early-stage business plan and minimum viable prototype (MVP) in order to test its desirability, viability and feasibility as a venture. Unum demonstrates how distributed manufacturing could work on the blockchain, using tangible products as examples of how this new business could be implemented in the short term and scale over time.

Audience & Setting for Final Forms

Impetus

Final Deliverable, Audience & Context

When the Internet first came out, many - like myself - believed that it was truly revolutionary. This powerful new tool represented the potential to fundamentally disrupt the industrial and business world, where power was hoarded by few and resulting socio-economic and business architectures were centralized, top-down, exclusionary and resistant to change. Indeed, the first era of the Internet fundamentally transformed how we communicate, allowing us to copy and share digital representations of our thoughts, actions, and business information more directly between individuals (peer-to-peer) and in a decentralized manner (the information didn't flow from one central source to individuals, it flowed between them). Due to this revolutionary ability, industries that relied on managing the flow of information to, from, and between people were deeply disrupted, and long-established companies and systems overthrown daily as more and more types of information (books, music, movies, product information, credits and debits) could be encoded into digital signals and shared widely between people.

One of the most important effects wrought by the decentralizing power of this 'digital revolution' was accessibility. Information is power, and those who have it can exercise this power to control and manage others. Through decentralizing the ability to create and convey information from a handful of large media companies to anyone with a computer and internet connection, the Internet opened up new marketing and distribution channels for entrepreneurs and small and medium-sized businesses (SMBs) to promote and sell their products and services. It both allowed for cheap online distribution channels, removing the need for complicated and costly relationships with physical retail outlets, and greatly reduced the cost of marketing, providing new businesses with low-cost advertising options, aggregation platforms and online marketplaces to drive customer discovery. For this reason, the last twenty years has seen a number of individuals or once small companies who have completely transformed the way business is done - Napster, Amazon, Netflix, Spotify, GrubHub, Uber etc.

While this decentralization of information transformed many areas, when it comes to things that have value, assets like money, intellectual property, or identity, the Internet has had serious limitations. The technology was never good at reliably establishing people's identities online or finding ways to help them to trust one another to exchange valuable things peer-to-peer versus regular information that can be copied and shared without any issue. In order to exchange things of value and carriers of value (currency/money) people instead had to use third parties like online e-commerce platforms, banks, or even governments to act as trusted intermediaries and ensure that valuable assets were correctly traded. This system has pervaded, with many online activities becoming decentralized but those that require creating, exchanging and managing assets and value needing a trusted third-party to facilitate trades between two or more people.

While this system has worked well in some ways, allowing people greater choice as both producers and consumers of goods and services, we have started to realize that this model also has unforgivable flaws. Today, we now understand that our growing reliance on third-parties to manage trust can have tremendously dire consequences. Many of these third parties capture our information for commercial gain and national security, only providing us the convenience of using their service at the price of our privacy and civil rights. What was supposed to help us have a 'sharing' economy has instead turned into an 'aggregating economy' where a handful of companies and platforms reap benefits from managing trust in our newfound ability to create content and our increasing desire to share it peer-to-peer online.

In many ways, the Digital revolution has been co-opted and the benefits it created appropriated through the creation of a new economic model, platform capitalism[1], where value is captured through people's desire to create and share content on decentralized systems. Since these distributed networks cannot adequately manage the trusted exchange of value, platforms provide this service - often for free - while acquiring huge amounts of information about people's online activities and selling them to the highest bidder.

For this reason, the economic, social, and political benefits the Internet was projected to create have occurred, but are distributed asymmetrically among people and communities. While our society has tremendous wealth creation, business growth, and accelerating innovation, we have falling real income and growing economic and social inequality. Like capitalism before it, platform capitalism has become so pervasive that most people can't even imagine how their digital lives could be different or how they could exchange things in new ways. Most now believe that no viable alternative economic model exists or could ever exist, that the capitalist paradigm is fundamentally inescapable. This is unacceptable.

My mission, through thesis and beyond, is to study emerging technologies through design practice and conclusively demonstrate that capitalism, whatever form it takes, is not the only economic future for our world. Though my methods and metaphors have transformed through the Thesis experience, I remain true to my desire to educate and empower others to imagine alternative economic paradigms for our future.

At its heart, Unum is really about the future, the future I want to live in. I don't want a future where I must rely on corporate and government owned platforms to coordinate trust, I want a future where I can trust and collaborate with anyone directly. I want a future where the fervor and excitement of the first Internet Revolution was never subsumed by greed, where its promised disruption shakes the core of our socio-economic and cultural realities. I want a future where decentralization extends from the digital to the everyday, empowering everyone to have more meaningful, personal, and sustainable relationships with one another, their products, their labor, and their world.

If you also believe in this future, a future where trust and convenience don't come at the expense of our data, our privacy, and our democracy, then I urge you to read on and learn how emerging technologies have the potential to revolutionize your future as well.

1 Sebastian Olma, "Platform Capitalism," P2P Foundation Wiki, , accessed April 11, 2017, http://wiki.p2pfoundation.net/Platform_Capitalism.

Secondary Research

Domains

Problem

Making Distributed Manufacturing a Viable Reality for the Future

"Power belongs to those who control the means of production." [1]

1 Adapted from Karl Marx

The Maker Movement represents a huge opportunity to address critical economic and environmental issues that have arisen under centralized, corporate-owned, and globally dispersed manufacturing systems. Riding on the coattails of the Internet Revolution, the Maker Movement was made possible by a reduction in the costs for searching, collaborating, and exchanging information between individuals, and lowering barriers to entry for entrepreneurs and small businesses to distribute and market their products through increasingly efficient and affordable digital design and fabrication tools.

Since the beginning of this movement, several platforms have tried to similarly leverage the Internet to connect designers, makers, and customers together in distributed manufacturing networks that allow for the local and sustainable production of globally-source designs. While many solutions have been proposed, they all rely on the same internet technology, which has serious limitations for business and economic activity since there is no way for people to reliably establish each other's identities online nor to trust one another to exchange assets of value (money, intellectual property, electronic health information, identity etc.) without validation from a third party like a bank, online platform, or even a government to prevent double spending.[1]

For this reason, while many have tried to make distributed manufacturing a competitive alternative to the way things are produced today, no organization has yet succeeded. There is both an urgent need and tremendous opportunity for new solutions and ventures that can address the Internet's critical limitations and find a way to create trusted collaborations directly between people, without the need for third parties. Distributed manufacturing will only truly be successful when individuals can also exchange the manufacturing supply chain's necessary assets of value in a similarly distributed fashion, without the need for intermediaries to manage trusted relationships between the players.

Problem Background

The Black Box of Manufacturing

Today, consumer goods are produced through complex global supply chains that look very much like a black box. Customers rarely know how, when, and where their products were originated,manufactured and transported. Before reaching end-users, goods must travel through a convoluted network of suppliers, distributors, retailers, and warehouses making it difficult to track provenance and creating negative environmental externalities as parts and finished pieces are transported back and forth or destroyed if unsellable. These massive supply chains also reward unethical labor practices by locating production in foreign countries with looser labor laws in order to keep product's prices low.[2] Given

1 Don Tapscott and Alex Tapscott, Blockchain revolution: how the technology behind bitcoin is changing money, business and the world (London: Portfolio Penguin, 2016), 45.

2 Saveen Abeyratne ., "Blockchain Ready Manufacturing Supply Chain Using Distributed Ledger," International Journal of Research in Engineering and Technology 05, no. 09 (2016): 1, accessed March 29, 2017, doi:10.15623/ijret.2016.0509001.

this complexity, people are often in the dark when it comes to the negative impacts of their consumer choices and given recent high-profile conflicts and law-suits revealing these issues, are increasingly demanding transparency in the manufacturing supply chains for the things they buy.

There have been many solutions proposed to combat this issue, from fair-tradecertifications to attempting to visualize end-to-end supply chains and provide retailers with the information. However, these solutions only raise awareness of the issue without attempting to tackle the larger systemic problems inherent in traditional, centralized manufacturing supply chain infrastructures. By only trying to combat the symptoms of a larger issue, organizations are missing out on an important opportunity to redefine way we design, produce, ship, market, and ultimately sell products in the future.

"Energized by the Internet and increasingly affordable technologies for design and production, the maker community has grown to include more than just its technical members. It has become a participatory movement for creating a future that, to paraphrase William Gibson, is here now but not yet widely distributed." [1]

1 Dale Dougherty, Ariane Conrad, and Tim O' eilly, Free to make: how the maker movement is changing our schools, our jobs, and our minds (Berkeley, CA: North Atlantic Books, 2016), XIX.

The Future of Manufacturing

Until recently, imagining a new manufacturing paradigm was almost impossible. Since the beginning of the heavy-industrial era, individuals have needed huge amounts of capital (money and production tools) to make manufacturing profitable at scale. They also needed access to distribution channels to help customers discover and purchase their products as well as space to store inventory for shipment. Traditionally, manufacturing has had high barriers to entry and individual entrepreneurs and small startups have had no way to compete with vertically integrated corporate factory networks and internationally dispersed manufacturing supply chains and labor pools.

However, new technologies are finally making it possible to disrupt this historically entrenched industry. First, the Digital Revolution decentralized marketing and communication channels once inaccessible to small and medium size enterprise. The internet allowed for cheap online distribution channels, removing the need for complicated relationships with physical stores and retail outlets. It also greatly reduced the price of marketing, providing new businesses with low cost advertising options as well as aggregation platforms and online marketplaces to help customers discover their products. Taking cues from this revolution, today's Maker' Movement has similarly given rise to the decentralization of production tools (capital) for digital design and fabrication, allowing a wider variety of people and organizations to design and produce a range of consumer products. This movement represents a huge opportunity to disrupt traditional manufacturing processes that rely on centralized fabrication and distribution architectures and global economies of scale to stay competitive.

"Today, anyone with an invention or good design can upload files to a service to have a product made, in small batches or large, or make it themselves with increasingly powerful digital desktop fabrication tools such as 3-D printers. Would-be entrepreneurs and inventors are no longer at the mercy of large companies to manufacture their ideas."[1]

1 Chris Anderson, Makers: the new industrial revolution (New York: Crown Business, 2014), 18.

From Maker to Micro-Factories

Like the digital revolution, the heart of the maker movement beats to the rhythm of emerging technology. Through the democratization of digital design and fabrication tools, and the spread of readily available information on how to use them, makers are increasingly transitioning from

hobbyists and tinkerers to entrepreneurs and startups in the small and medium manufacturing sectors.

Across every industry, disruptive technology empowers people to build businesses that once required massive investments in capital - land, labor, and money - right from their basements or local coffee shops. Manufacturing is no exception to this rule. Digital fabrication tools have rapidly increased manufacturing capabilities so that companies only require a handful of machines and staff to perform the same actions as a full-scale factory only a decade ago. In addition, the cost of these tools - CNC routers, Laser Cutters, 3D Printing - has been falling rapidly and new cloud-based production management tools allow small companies to cheaply manage ordering, stocking, and business management.

Similarly, new software and online platforms have made it easy to create, iterate, and customize product designs for digital fabrication, allowing for the mass-customization and on-demand production of many types of goods including furniture and organization units, electronic hardware, art, clothing, home goods and more, and reducing the need for space to store materials and inventory.[3] Given these innovations, many products can now be fabricated completely on-site, allowing makers and maker centers to become competitive micro-factories in a range of sectors.

3 Ivan Rabodzeenko, "The Return of Urban Manufacturing," MAKE Company Culture, December 17, 2015, , accessed April 07, 2017.

Solution

The Case for Distributed Manufacturing

Driving Change at the System Level

As stated earlier "...the current supply chain structure obfuscates the processes, means, and costs, on all levels, of production from the actual value of products and services".[1] Since the conditions of production are hidden from or willfully ignored by consumers, the prices paid for goods do not reflect the true costs of their production, rather they do not internalize the negative externalities created through their fabrication and transport, nor set prices to reflect this higher value to society. We are now coming to realize that the consequences of a consumer culture where the repercussions of our economic actions are opaque is increasing environmental degradation and the continued exploitation of foreign labor at the expense of local employment.

For these reasons, it is urgently necessary that we don't just seek to reveal and minimize the negative externalities that traditional manufacturing supply chains create. What we need now is to reprogram the model itself at the systems level by imagining a new paradigm for manufacturing that is more transparent, community-driven, and re-locates production around consumers. By harnessing the increasing power and potential of the maker movement, we can meet this need by building more distributed manufacturing networks that allow for a variety of makerspaces and to partially or fully act as micro-factories, able to meet customers' product needs with on-demand fabrication of just-in-time items made from local materials, and created by local labor.

Through shifting to a more distributed manufacturing landscape, supply chains can be transformed into supply circles, where production and consumption systems engage consumers directly in the processes that bring them their goods. Local makerpaces are already important community assets that provide space and education for members to rapidly prototype and create products to meet a variety of personal and community needs. By integrating these spaces into a distributed manufacturing network we can create local economies of scale that prioritize local labor, local and ethical materials, and remove the environmental costs of global transport. In addition, since digital designs can be created separately from finished products, it is also now possible to source designs globally and have them produced locally, ensuring that consumers still have plenty of choice in style and affordability to match their purchasing preferences.

The Challenges of Distributed Manufacturing

Just like the internet decentralized information, manufacturing technology innovations have decentralized production and similarly driven the marginal cost for making things closer and closer to zero. It has also removed capital-based barriers to entry for individuals and small businesses, laying the foundation for a more distributed manufacturing industry where several different sized companies can meet consumer demand as well or better than the current top-down centralized system. Many business leaders and economists already see this shift occurring and believe the maker movement is one part of a larger industrial revolution that signals the end of the capitalist era. They predict that the rise of distributed manufacturing in conjunction with new collaborative and networked relationships directly between people all over the world will replace traditional business models by the end of this century.

But the reality is that the infrastructure needed for this 'revolution' to disrupt traditional manufacturing relation-

1 ConsenSys, "The Supply Circle: How Blockchain Technology Disintermediates the Supply Chain," ConsenSys Media, March 09, 2016, , accessed April 01, 2017.

ships is not yet in place. While the technology exists to democratize the design and production of goods, no viable solution has yet been found to manage trusted business relationships between the key stakeholders of manufacturing in a truly distributed fashion. Until designers, makers, and customers can connect with one another peer-to-peer to exchange the necessary assets of value inherent in these relationships (money and intellectual property) distributed manufacturing can become a viable competitor in the economy.

Two solutions currently exist that try to address this problem. One one hand, designers can either send or list their digital designs on platforms like Shapeways and Thingiverse. These companies will either produce a run of products and ship them to the designer to sell on their own, or price and list the item on their in-platform marketplace and produce it on-demand from a preset range of customization options every time a customer buys a copy, allowing the designer to set a markup fee to make a profit if so desired. While this is great for designers, the products are shipped from wherever the platform's factory happens to be located, negating any economic or sustainability benefits that come from centering production around a consumer's location.[2]

Other organizations are trying to address the idea of locating production around customers by adopting models from the open-source software movement to create 'open-making' networks. In this solution, online platforms such as Opendesk allow designers to list design files on their website that anyone can download and fabricate non-commercially through creative commons licensing. If customers do not have the necessary fabrication tools to produce the designs themselves or if they require a large number of items that exceeds their production capacity, the platform will connect them with the closest available partner makerspace to fabricate the products for a fee. Designers are only paid for their intellectual property if the design is fabricated in this fashion and do not receive any compensation when people directly download and create the item themselves. While this solution does center production around consumers, it has two serious flaws.

First, listing the design openly on the platform means that designers have no way of securing their intellectual property. Anyone could download, copy and distribute their file and there is no realistic way to ensure that the non-commercial license granted upon download will not be violated once the physical object is fabricated. These unclear property rights hurt designers. Since many physical products now begin as digital designs, intellectual property and design files will become some of the most important assets of the future. Whomever owns and can leverage the rights to these products, rather than those that manufacture, sell, or distribute them, stand to profit the most. Hence, it is unrealistic to assume designers will be willing to give away their intellectual property for free.

Second, our interviews with makers participating in open-making platforms have revealed that the design files listed on the site are not ready for on-demand production.[3] Due to differences in materials, fabrication equipment, and production processes, there is a large amount of pre-work that must go into testing and building the product that makers are not compensated for. This isn't as big of an issue when creating large-runs of products, but it makes on-demand production unprofitable if only making one copy of a design. makers consider the adjustments and production processes drafted during the prototyping period as their own intellectual property, or a manufacturing kit that is just as important as the actual design file. These types of platforms don't take this time into account and have no viable way to allow makers to share and be compensated for this sort of work.

In order to solve these issues, there must be a way to coordinate trust directly between designers, makers, and customers when creating physical products that originate in digital designs. What is needed is an equally distributed value network that can connect these parties peer-to-peer in order to create, manage, exchange, and be compensated for their contributions to the production process. Until this infrastructure is created, distributed manufacturing will remain an interesting social experiment and niche production method instead of a revolutionary new way to purchase sustainable, locally produced consumer products on-demand.

2 Shapeways Inc., "How 3D prints are priced at Shapeways - Shpeways," Shapeways.com, , accessed April 07, 2017, https://www.shapeways.com/support/pricing/?li=t_menu.

3 Williamson, Bryce. "Maker Interview: Stokes Design & Fabrication." February 24, 2017.

Blockchain

The Trust Protocol

What is a Blockchain?

"By utilizing blockchain technology, we can build the necessary internal and external value networks for an entirely new infrastructure for provenance and supply chain management that is transparent, ethically minded, and community-driven."

Some have hailed the blockchain as the most important invention in computing, a second-generation Internet revolution that can rewire our economy and disrupt the asymmetrical economic power structures created through the proliferation of corporate capitalism.[1] Simply put, the blockchain protocol is a software mechanism that "...provides a distributed system of trusted assets and transactions without the need for a central trust authority."[2] Best known as the term for the database underlying the cryptocurrency Bitcoin, the blockchain refers to any distributed electronic ledger that uses cryptographic software algorithms to reliably and anonymously record transactions. At its core, the blockchain is a self-sustaining, peer-to-peer database that can manage and record transactions without a clearinghouse to prevent the double spending problem inherent in digital information and assets.

There has never before been a way to facilitate trusted transactions directly between two or more parties that is authenticated by mass-collaboration and powered by collective-self interest. Instead of an Internet of Information, the blockchain can be thought of as an Internet of Value that can be programmed to record virtually anything of value: financial records, provenance of items, money, intellectual property and anything else that can be translated to code.[3] Blockchains can also run smart contracts, pieces of software that can automatically implement terms of multiparty agreements. "Smart contracts are executed by a computer network that uses consensus protocols to agree upon the sequence of actions resulting from the contract's code. The result is a method by which parties can agree upon terms and trust that they will be executed automatically with reduced risk of error or manipulation."[4]

The Blockchain & Distributed Manufacturing

The blockchain protocol can create a distributed value-network to support equally distributed manufacturing networks, spinning a digital thread that represents a product's lifecycle from initial design to ownership of the finished product. Since these transactions are tracked digitally, designers and makers who are geographically separate can collaborate in a trusted fashion to create products and be automatically compensated for their contributions. It can even allow for a design to be remixed, allowing other designers to modify the original and submit their version, compensating every designer along the chain each time the file is produced.

In this way, the blockchain remains true to the ethos of open-making by creating middle-ground between truly open and proprietary designs where anyone can collaborate on products and be paid for their intellectual property. Blockchains immutability, auditability, and transparency securely record a product's lifecycle making it's supply chain completely transparent. Finally, they can know exactly where their products came from. and making them more informed of their impact as economic actors.

1 Don Tapscott, "Five Myths About the Blockchain Revolution," The Huffington Post, May 23, 2016, , accessed April 07, 2017.

2 Prasad Satyavolu and Abhjeet Sangamerkar, "Blockchain's Smart Contracts: Driving the Next Wave of Innovation Across Manufacturing Value Chains," Cognizant 20-20 Insights, June 2016, 1, accessed March 24, 2017.

3 Tapscott, Blockchain Revolution, 49.

4 Jacob Boersma, "Blockchain based smart contract use cases in industry | Deloitte," Deloitte Nederland, December 21, 2016, accessed April 07, 2017.

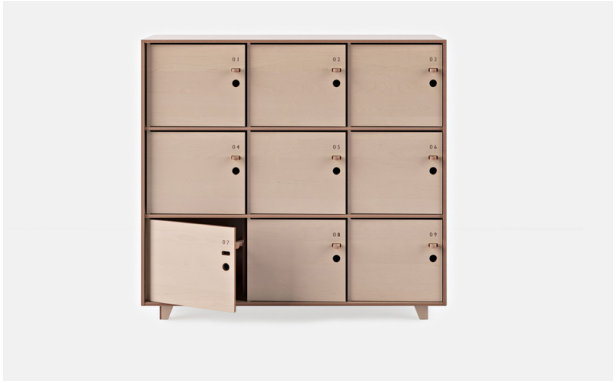
Precedents

Competitor Analysis

opendesk

Opendesk

https://www.Opendesk.cc/



Summary

Opendesk is a global platform for local making. It can be used to download, make and buy work space furniture. They support a global network of makers and a collection of furniture by a range of international designers. Because that furniture is designed for digital fabrication, it can be downloaded as a digital file and made locally — on demand, anywhere in the world.

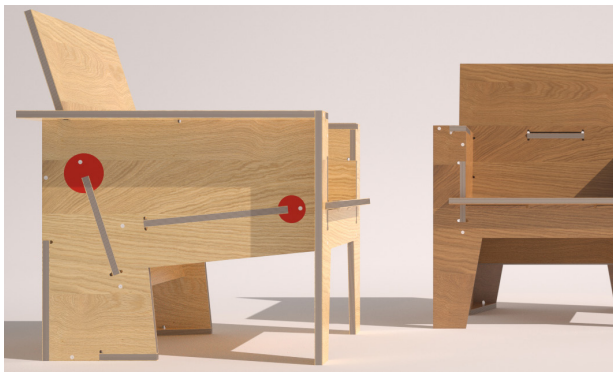
Opendesk calls this concept, “Open Making” which is designed to benefit designers, makers, and customers. Designers get a global distribution chain, makers get profitable jobs and new customers, customers get designer products without the designer price tag, a more social, eco-friendly alternative to mass-production and an affordable way to buy custom made products.

Key Insights from Precedent

The ideology of ‘open-making’ was inspiring and helped drive early iteration away from solutions focused on licensing/proving authenticity via the blockchain, rather than using it to coordinate relationships. Opendesk list of partners also allowed me to find NYC-based manufacturers who had worked with the platform to understand how well it worked, what challenges it had, and how the blockchain could potentially address the challenges. Unum seeks to operate very much like Opendesk and provides similar benefits to its members. The difference is that no files on Unum will be free for download at this time, they will all be available as on-demand copies made from maker partners.

AtFAB

http://atfab.co/



Summary

AtFAB is a design firm co-founded by architects Anne Filson & Gary Rohrbacher, who are dedicated to creating simple, durable, modern objects. They seek to design goods that are beautiful both in appearance and in how they are designed, manufactured, and delivered. They started AtFAB to design things specifically for digital CNC fabrication tools and networked manufacturing, in order to provoke a new way of designing, making, and buying things.

Key Insights from Precedent

AtFAB is a company also looking into disrupting typical notions of producer/consumer relationships. Their products are all available for free download and can be produced under a creative commons license for non-commercial use. They also work with Opendesk to coordinate with a network of makerpaces for fabrication. AtFAB is an important precedent because it represents a realistic line of products that can be produced through distributed manufacturing relationships. The simple CNC designs are made to be produced this way and meet the diverse needs of people who are price-conscious and move often. They are a great inspiration for the types and qualities of products that should be put on the Unum web store in terms of functionality and affordability.

hem

Hem

https://us.hem.com/

Summary

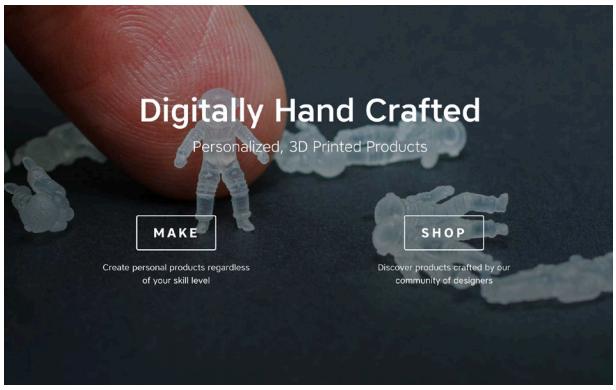
Hem is developing unique designs together with some of the most relevant designers of today. They deliver directly to customers to ensure the best possible price, without compromising on quality. Hem partners with an extensive network of experienced designers and manufacturers to create original designs. They sell their products directly online to keep them more affordable and attainable than design furniture usually is. They also innovate on assembly solutions to make things easy for customers.

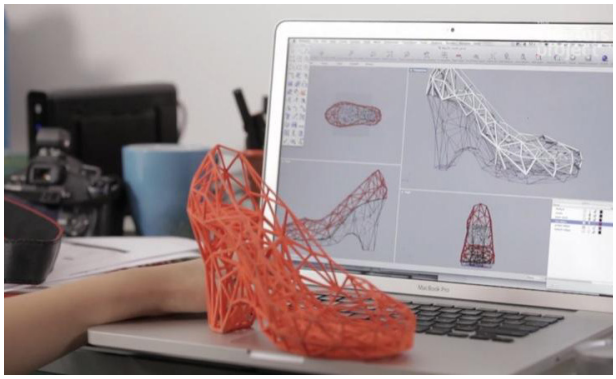
Key Insights from Precedent

Hem was an important aesthetic precedent, both for the types of designs they create and the price points they are available at, but also for the overall look and feel of their webstore and purchasing experience. Hem is a unique solution to making factory-direct high-quality and timeless designs through coordinating relationships between designers and factories while being in charge of customer discovery and online experience. Looking at Hem's structures and values helped to clarify the role and mission of Unum as a company, albeit with a distributed versus centralized model. It also helped to shape language around organizational prioritie

Shapeways

https://www.shapeways.com/





Shapeways 3D Printing Marketplace

Summary

Shapeways is the world's leading 3D Printing marketplace and community. They enable anyone to make, buy, and sell products with 3D Printing. All Shapeways products are designed by their community members some of whom offer freelance design services. All designs are made in their two "Factories of the Future" in Long Island City, NY and Eindhoven, Netherlands. They also work with manufacturing partners around the world through their Global Partner Network, to enable printing in more materials.

Key Insights from Precedent

While 3D printing has a lot of promise for the distributed manufacturing of parts, homegoods, fashion accessories and more, the current builds require a lot of post-production, making it difficult to facilitate in a distributed manner today. Shapeways addresses this issue by locating all production in one location, but allowing a distributed global community of designers to list their items on the marketplace. This model helps the organization ensure quality, standard production of designs on a variety of materials through coordinating institutional knowledge of production processes in few physical factory locations. For this reason, Shapeways was an initial inspiration, given their unique perspective on separating digital designs from physical products, but not as a business model for replication.

BITMARK

Bitmark

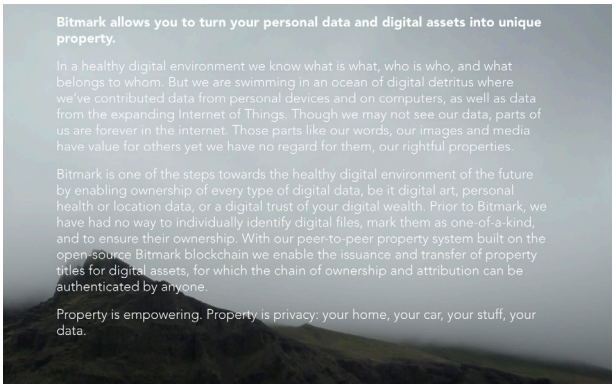
https://bitmark.com/

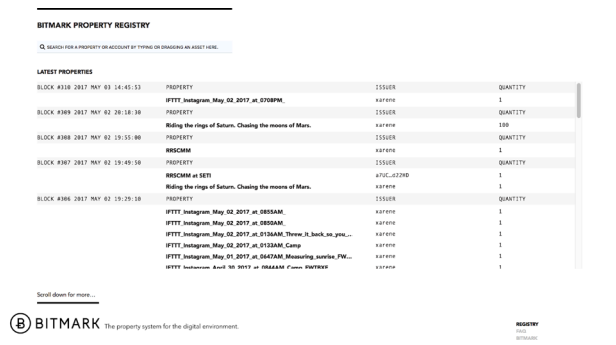
Summary

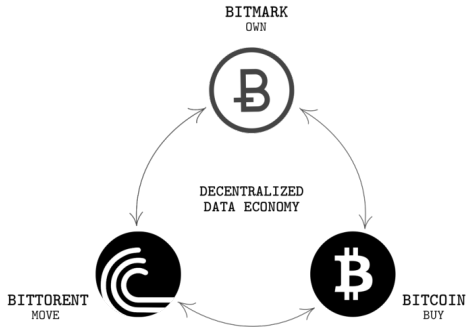
Bitmark allows people to turn personal data and digital assets into unique property. They consider their venture to an important step towards the healthy digital environment of the future by enabling ownership of every type of digital data, be it digital art, personal health or location data, or a digital trust of digital wealth. Using the blockchain protocol, bitmark supports a peer-to-peer property system built on the open-source Bitmark blockchain that enables the issuance and transfer of property titles for digital assets, for which the chain of ownership and attribution can be authenticated by anyone.

Key Insights from Precedent

Bitmark is a brand new venture that seeks to similarly coordinate both intellectual property and ownership using the blockchain protocol. The way their blockchain works is public and provided invaluable information that helped test assumptions around if and how the Unum blockchain d'app could work. Their model helped explain the role smart contracts play in interacting with blockchains to record and exchange idea ownership and version data.

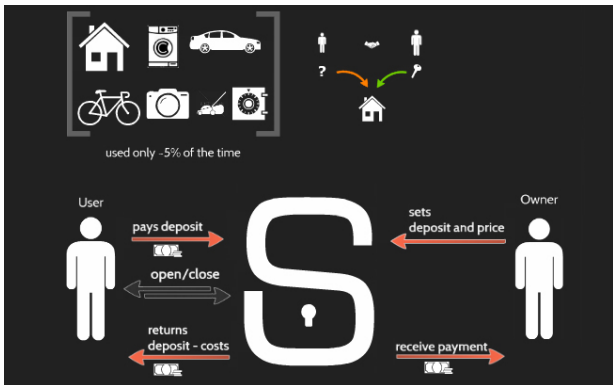


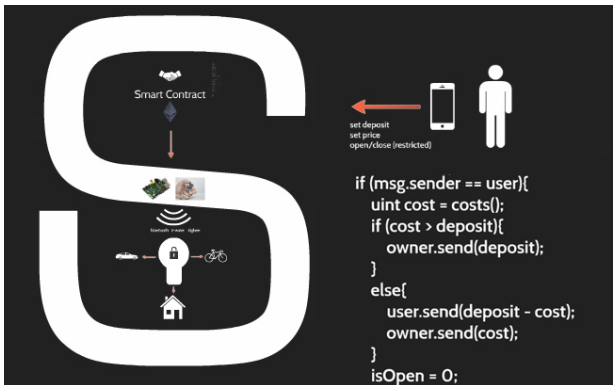




SlockIt

http://slock.it/





Summary

Slock.it brings the benefits of the Blockchain - transparency, security and auditability - to real-world object (blockchain + Internet of Things). The technology can be embedded in almost any device and the first prototypes are already in the hands of developers. Slock.it considers the sharing economy, the industrial/maker/manufacturing space, supply chain management, maritime contracts and shipping, energy and clean energy, and smart homes to be the main areas their technology can be leveraged and work with startups in various sectors to build proof of concept solutions.

Key Insights from Precedent

Slock.it is similarly trying to identify real-world objects on a digital blockchain, for the purposes of exchange, management, and transparency of access and ownership. Slock.it was very helpful in providing an understanding of how the blockchain protocol could work to link physical/digital property together, and how a blockchain could facilitate coordination between different parties who needed public or private access to that information.

Methodology

Primary Research,
Prototyping & Testing

Primary Research

Interviews with Customers, Designers & Makers

Several qualitative interviews were conducted with key stakeholders: designers, makers, and potential customers in order to test assumptions regarding the scope of the problem from each party's point of view and how solutions proposed through design questions could address their motivations, goals and current pain points/ challenges. Starting with the design questions and secondary research performed, several user characteristics were drafted to help streamline the interview selection process. These user characteristics were later developed into screener questions to quickly identify if potential interviewees were the right fit.

User Characteristics for Identification

CUSTOMERS	
Physical/Demographic	**Cognitive**
25 - 40 (could be older) early -> mid-career	Literate and speak at least some English
Both men and women (or non-identifying genders)	Care about sustainability and "local" even if just fashionably, but want to be able to do more and say they are supporting it.
Citizens, Immigrants, Any Legal Status	Prefer using money for experiences rather than just "things". This can be represented as buying materials for DIY experiences or spending money on travel, food, etc.
Generally physically fit and dextrous (can use hands and body to build/assemble items from instructions)	Don't necessarily want to own lots of things, but want the things they own to be meaningful or unique. Care about good design and unique design.
Make between $40,000 - $100,000 annually (NYC rate) or rather they have enough extra-income to buy non-essential items, but not enough money to buy lots of luxury and frivolous items	Likes collaborating and feeling like they are connected to communities, whether their physical community, communities based on interest or work, or digital social circles around topics, interests, brands.
Make between $40,000 - $100,000 annually (NYC rate) or rather they have enough extra-income to buy non-essential items, but not enough money to buy lots of luxury and frivolous items	Generally familiar with technology and can navigate websites and mobile applications with relative ease. Digital natives. Can't necessarily do anything super technical, but can use technology.
	Has heard of the maker movement and knows enough about digital fabrication to have heard of 3D printing and laser-cutting, although they don't have to know the specifics or have tried any of them.

Customers

Physical/Demographic	Cognitive
Probably Younger (Student/Early-Career Designer) But not necessarily	Interested in getting their work out there online, comfortable with selling online
Physically able to create products/furniture/art in terms of strength and dexterity needed to assemble/cut products	Comfortable with other people handling the actual production of their designs or open to trying it out.
People who are familiar with digital technologies (smartphones, laptops) and are comfortable conducting business over the internet.	Creates work that can be easily reproducible on CNC, 3D Printer, or Laser.
People who have a mid-high level of English literacy and are able to read a simple and clear digital interface.	Doesn't have time/money/supply chain to produce several copies of their work (do their own manufacturing or Etsy style selling).
	Interested in sustainability, supporting local manufacturing, and would be willing to fit their products or make new types of products that support a model where their designs are reproduced by maker centers.
	Has heard of the maker movement and knows enough about digital fabrication to have heard of 3D printing and laser-cutting, although they don't have to know the specifics or have tried any of them.

Maker

Physical/Demographic	Cognitive
Maker centers and fabrication workshops that have Laser Cutters, 3D Printers and/or CNC Machines	Interested in learning about new revenue models for maker centers and how they will fit into new manufacturing processes
Either already do some local manufacturing for online sources or would be interested in doing more	Open to producing a certain catalog of products within a set range of materials
Can be for profit, non profit, cooperative or other business model	Open to using our platform to receive, queue, manage, and produce products within a reasonable time-range
Have the space, people, or desire to do more making to bring in revenue	Open to using our platform to embed physical products with a digital license
	Open to delivering or preparing items for local/regional delivery

Interviews

The following individuals were interviewed between October 2017 and April 2017.

Makerspaces

Micro-manufacturers, hackerspaces, fab-labs etc.

Business & Revenue Models

- Makerspaces have a variety of legal business models ranging from non-profit (typically smaller makerspaces and hackerspaces) to traditional corporate models (typically micro-manufacturers) though all interviewed insist they have an informal and flat management structure.
- There are a diversity of organizational missions (ethoses) when it comes to the role of the space in everyday business. Clearly identify whether or not the makerspace as an organization or just a maker using the space is our client.
- Small makerspaces have limited space and few machines that are in constant demand by paying members. Prioritize makerspaces with enough machines or space for new machines to be dedicated for micro-manufacturing purposes.
- Makerspaces rent machine space for walk-in clients, providing a valuable revenue model. They must make as much or more money from dedicating machines to micro-manufacturing so that this revenue line is cost-effective.

Challenges

- Many members of makerspaces use the facilities to prototype an idea with digital fabrication tools. When scaling up to production, their needs overwhelm the center's capacity, so they must turn to traditional manufacturing processes. Unum could also be an opportunity to provide an alternative model for small to medium-batch production needs.
- Makerspaces often can't take out traditional business loans, but they make enough money and need new equipment rarely enough that they can pay in cash or through private credit. Some more member-focused models will also leverage community funding and collect money from members in return for free future time on the machines.
- Many micro-manufacturers have their own products for sale. They typically sell these products on online stores and pop-up sales/local events. Marketing and discoverability is a challenge for these businesses.
- Makerspaces have limited room. There must be multiple copies of tools, some for the education and rental side for members, and others that are just for fabrication and manufacturing. Consider promoting a dual member/employee structure where revenue is earned from membership, classes, and employees working on dedicated machines to do small-batch or on-demand manufacturing.
- Right now, on-demand production from open-making types of designs don't work. There is too much testing from initial design to finished product. Then only one copy is made and the time spent isn't worth the money paid, or the price has to be driven way up.
- The information gained from testing the first build of an object, or its manufacturing kit, is an important tool and piece of intellectual property that micro-manufacturers use to keep designers working with them. If they need to leave, the kit is sold back to them so they can use it to make sure production goes smoothly at a larger scale. This is especially necessary when working with chinese factories.
- In order to make this model work, it is necessary to rethink how makers achieve consensus. Is there

a way to connect the makers in a network that allows them to have more control over the designs coming in, especially at the start? One way to do this is to allow makers to review the designers file and vote whether or not it should be produced.

Other Insights

- More professionally oriented makerspaces and micro-manufacturers carry product liability insurance to protect themselves and designers.
- Micro-manufacturers pay above average wages, with the average salary for a CNC operator between $20 and $25 an hour, and Product Finishers/Assemblers receiving between $15 and $25 an hour, commensurate with experience. Given the low capital needs of these types of businesses, labor is often the most expensive cost.
- Blockchain-run smart contracts could be used to improve coordination with designers, letting makers negotiate with them and coordinate necessary information for negotiation. It would also help set up standards and rules to make sure everyone is fairly compensated when the designs are made real.

Suggestions for Unum Web Store

- Begin by curating designs for products with a small surface to edge ratio. Things like organization units and shelves have minimal finishing time for this reason.
- Stay away at first from things that require a lot of sanding and finishing or that don't look good when built from simple, parametric designs for plywood and other widely available CNC ready materials.

List of Interviews

Makers

- Stokes Design & Fabrication - Micro-manufacturer located in Queens, NY
- NYCResistor - Hackerspace located in Brooklyn, NY
- AtFab - Design firm producing designs for digital CNC fabrication tools and networked manufacturing. Located in Kentucky, but a distributed manufacturing company.

Designers

- Matt Callahan, MFA Industrial Design student at Parsons School of Design
- Tim Ronco, MFA Industrial Design student at Parsons School of Design
- David Marin, Assistant Professor of Modeling Technology
- Lisa Marks, Part Time Faculty Product Design & MFA industrial Design student at Parsons School of Design

Customers

- Several students and faculty at Parsons School of Design who met the requirements outlined in the user characteristics above were interviewed.

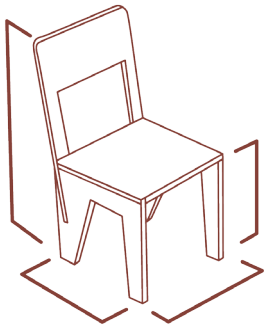
Other Experts

- Tom Bosket, Expert on Hudson Valley Makers
- Consensys, Blockchain venture production studio located in Brooklyn, NY
- Bill Bodell, Creator of Farmshare, a Hudson Valley blockchain organization for Community Supported Architecture
- Jennifer Van Der Meer, Founder and CEO of Reason Street and Assistant Professor, Strategic Design and Management at Parsons School for Design

Personas

Character Archetypes Built from Interviews

From the interviews above and secondary research following up some of the opportunities and challenges identified, several personas were drafted for customer, designer, and maker stakeholders. These personas were used to generate scenarios, or walkthroughs and generate a list of core requirements to test in prototypes.



Designer

Lepht is a graduating product/industrial designer living in Brooklyn, NY. She has several beautiful designs and prototypes made throughout her time at school, but once they were made and shown for class, never had time to follow-up on producing them for sale. She is a bit broke from financing her degree and currently works part-time as freelance designer and research assistant making only $18 an hour. If she isn't working for her job, she is working for class and doesn't have much free time. Lepht loves to both use and modify open-source designs as well as well as sharing her own files, but she is realizing she can't keep giving her designs away for free if she wants to make money. She is interested in exploring sustainable materials and digitally fabricated furniture that can be made using a CNC router, as well as assembled with as few fixtures as possible for easy assembly and disassembly at will.

Pain Points

Lepht has trouble finding a platform to sell her designs, given how little time she has to produce them and the cost of buying materials retail in small quantities. She has considered sites like Shapeways and Thingiverse, but most of their products center around 3D printing. She also doesn't want to list her designs on Amazon Marketplace or Etsy because she is concerned that she won't be able to meet demand during her time in school and feels intimidated by the need to package and ship everything herself..

Goals

Lepht wants a way to promote and monetize her parametric CNC furniture designs without having to build them all herself. Since Lepht is relatively up and coming, she has no idea whether or not her designs

will be popular, and is afraid that she will be overwhelmed by demand if she has to produce them herself. Consequently, while she would love to participate in an online market where her designs can be created on-demand from a range of sustainable materials of her choosing, she can't find a current e-commerce or on-demand fabrication platform that meets her needs. Lepht also wants to promote her designs in blogs and online design magazines to gain recognition. She would like to connect with other student designers to explore both collaborations across mediums (smart-objects, CNC + 3D printing etc.) and partnerships that can increase chances of getting recognized by the design world or press.

Maker

Bridgette is the co-founder of a new fabrication lab (fab lab) in Queens, NY. She was able to open the space last year with grant money she received from a start-up competition focused on up and coming Maker in NYC and support from NYC government agencies to support local manufacturing. Given the suggestions of her business mentors, Bridgette created the space according to the core capabilities of a fab lab, a set of international standards that allow people to share projects across centers. As such, her business model is focused around membership dues, fees for renting space to walk-in clients, and a small set of classes. She she is using the fablab model, her space contains the following pieces of key equipment:

- A computer-controlled laser cutter, for press-fit assembly of 3D structures from 2D parts
- A larger (4'x8') numerically-controlled milling machine, for making furniture- (and house-) sized parts
- A signcutter, to produce printing masks, flexible circuits, and antennas
- A precision (micron resolution) milling machine to make three-dimensional molds and surface-mount circuit boards
- Programming tools for low-cost high-speed embedded processors

Pain Points

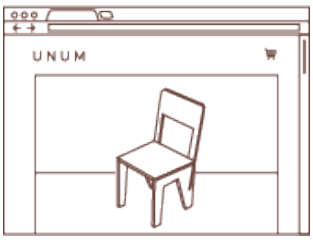
Bridgette's shop isn't located in an area with high-foot traffic nor many retail corridors, so it is hard for people to find about her business. As a result, she must put a lot of time and energy in promoting the space and looking for enough individual and start-up members to meet her income requirements. In addition, the community her shop is located in has a high level of poverty and most locals can't afford to take classes even though they are interested in learning about the tools. For this reason, education hasn't been a great source of revenue for the business and most students come in from other parts of the city.

Goals

Given these challenges, Bridgette and her partner want to find a more sustainable revenue model for their shop, and have started to take in some local fabrication work for small-businesses who need signage,

tradeshow furniture and displays and even set design. Given this success, they are interested in converting a portion of the business to support local manufacturing and hiring local employees to meet the increased demand. Bridgette would also like to explore becoming part of an open-making or distributed-manufacturing platform such as Opendesk, or FabCity, but has had bad experiences working with these types of design in the past, as they are often not production ready.

Bridgette and her partner need a new revenue line that can help them have a predictable income stream from taking on on-demand and small-batch manufacturing projects without an unreasonable demand on staff or need to stock a large variety of extra materials . Given the social mission of the fab lab, they also need to demonstrate impact at the community level. Since classes have not been well-attended, they want to find another way to financially and culturally support the community and are interested in job-training, internships and employment opportunities for local residents.



Customer

Tristan is an early-career professional who is starting to finally feel like a 'real adult'. While he is still working to pay off student loans, he is finally making enough money to have a little left over for purchases. Usually, he likes to spend this money on experiences such as eating and drinking out and going to cultural events. However, he recently moved into his own apartment and is excited to finally decorate it according to his own individual style, rather than the second-hand furniture and accessories he has collected for free or cheap over the last few years.

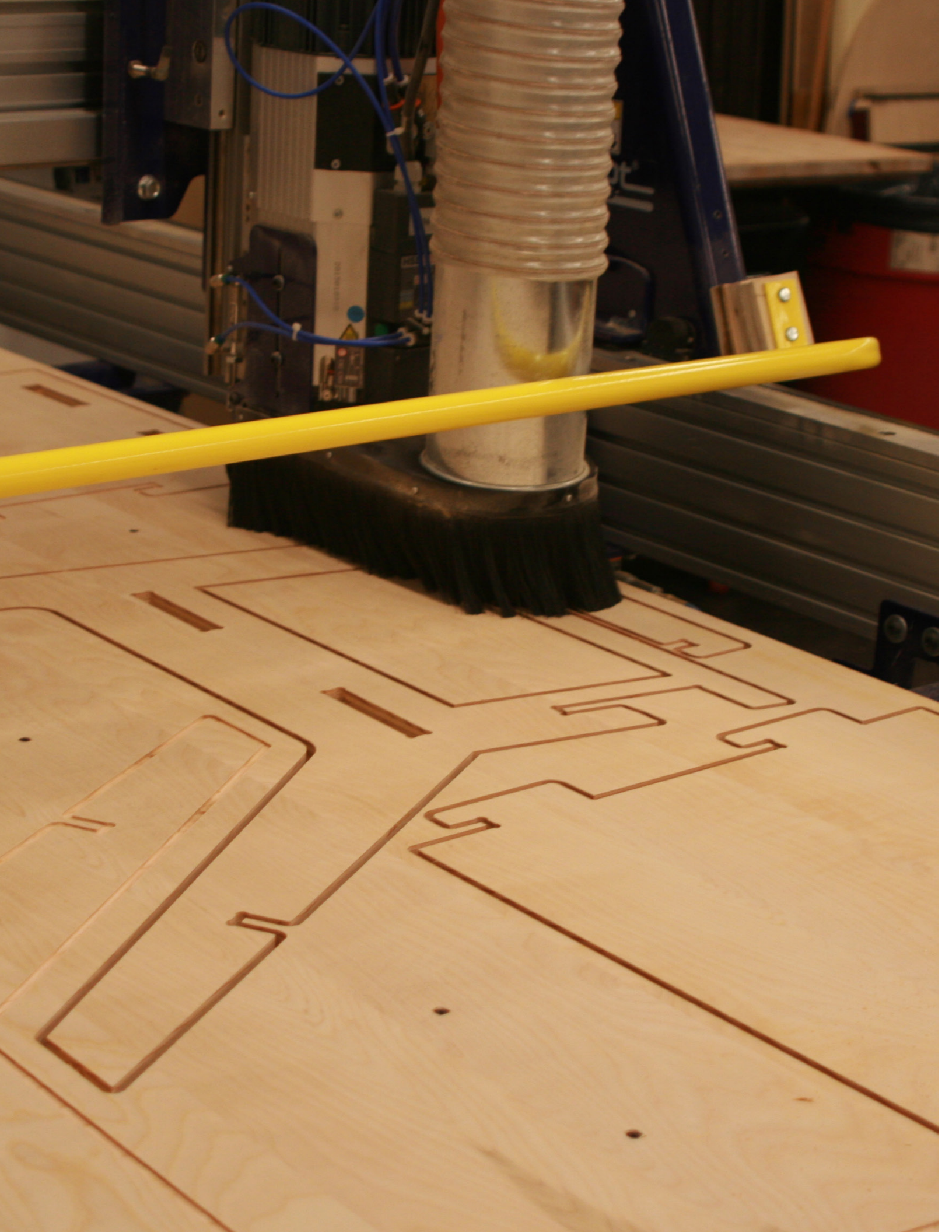
Tristan prizes customization above all and wants to feel like he is part of the design process for his items, whether requesting a custom piece of artwork or being able to paint unfinished furniture in the colors he wants - much to the consternation of his boyfriend. He has often heard about the DIY and Maker Movement and thinks they sound cool, but has never had a chance to get involved given his busy work schedule. He also doesn't consider himself much of a 'builder', beyond assembling IKEA furniture, and is intimidated by both the traditional and digital tools that makers are using today. In addition, while his current furniture doesn't yet reflect it, Tristan cares deeply about sustainability and supporting local artisans, but products from small and innovative design studios are way out of his price range, even now.

Pain Points

Tristan can't find affordable, unique, and customizable designs that are manufactured responsibly and support local maker and artisans. He has also tried shopping in online peer-to-peer marketplaces like Etsy and Amazon Marketplace, but still found their prices a bit too high and the production/shipping time too long. While he is willing to pay more for products that meet his purchasing preferences, he still has a budget, and can't find anything in his price range. Also, while he is interested in buying and customizing unfinished furniture, he doesn't have a place he can spray paint in his apartment and isn't sure where he could go to do this.

Goals

Tristan wants to have cool, unique, and customizable furniture and home design products that help him stand out, but he needs to save money and would be interested in spending a reasonable amount of time assembling or making the product if it lowered the price. He is also interested in new production methods and technology. He has heard of CNC and 3D printed furniture, and is interested in learning more about how digitally fabricated furniture could meet his needs.



Core Requirements

Key Functionality for Technology Testing

From personas and related storyboarding exercises, the below list of requirements was generated to guide designing prototypes of each of the different user interfaces the Unum platform will have for various stakeholders.

Assumptions about whether these features are needed, priority, or irrelevant can be tested through prototyping the interactions between customers, designers, makers and the interfaces they will use.

CUSTOMERS	
Information They Need	**Actions They Must Be Able to Take**
Designs Available (sort or filter by type, designer, price)	Select a Design
Design Details	See Designers Information
Price of the Design	Purchase a design
Customization Options	Learn about maker partners near them
Materials	Stay updated as to the progress of their products fabrication
Sizes/Builds	Generally familiar with technology and can navigate websites and mobile applications with relative ease. Digital natives. Can't necessarily do anything super technical, but can use technology.
Fixture Options	Has heard of the Maker Movement and knows enough about digital fabrication to have heard of 3D printing and laser-cutting, although they don't have to know the specifics or have tried any of them.
Design Ratings & Reviews	
Designer Information	

DESIGNERS

New Designers		Registered Designers	
Information They Need		**Actions They Must Be Able to Take**	
Information about how to join Unum	Learn about how Unum works for designers	Upload a New Design	Login to Designer Dashboard
Requirements for submitted designs	Learn about Designer registration process	Same info needed as new design process above	View Designer Dashboard
Machines and production processes used	Request to join Unum	View their Dashboard to gain insight on all designs	Information about All Currently Listed Designs
Materials allowed		View info about specific designs	How much money was made for all designs (aggregated)
Price range allowed		Update or Change their biography, contact information and/or payment methods	Which designs are currently being built
Pictures and descriptions of prototypes or test-builds		Request Help/Contact Staff	Where designs were made (aggregated and viewed geographically and by Makerpace)
Instructions on How to Upload a design for submission			Sales statistics and trends (optional feature)
File Upload instructions			New Reviews and Comments about their listed designs (optional feature)
Description of the design			Information about a Specific Listed Design
Dimensions of each part of the design			How much money was made for this design
Bill of Materials Needed (can choose 3 material options)			Where this design has been made (geographically and by Makerpace)
Build Options & Sizes (can choose 3 versions of design for sale)			Reviews/Comments on this design
Designer Information, Biography, Contact Information			Aggregated Reputation Score based on Reviews/ Ratings (optional feature)
Payment Information (PayPal, Bitcoin, Credit Cards)			

Maker

New Maker		Registered Maker	
Information They Need		**Actions They Must Be Able to Take**	
Information about Unum for Maker	Learn how to become a maker partner.	How to log in to their Maker Dashboard	Log in to Unum's Maker Dashboard
Basic tool, space, material requirements to become an Unum maker partner	Clearly understand the benefits of the model	Notifications and information for newly submitted designs	Access the Maker Dashboard
Projected financial and social benefits of becoming a partner (how much they can expect to make)	Clearly understand how they will be compensated for their work	Notifications and information for new test-build opportunities	Check out a requested design for production
How to request becoming a maker partner	Clearly understand how Unum's business model works to support them and what the role of Unum is on the platform	Notifications and information for new orders for production	Access Design Kit and Manufacturing Kit information for all new orders
	Submit a request to become a maker partner (name, contact info, website/portfolio, shop information)	Materials	Confirm that a product has been completed and shipped or picked up by the customer
	Contact Unum team with questions or to get help filling out forms	Production Timeline	Register an Unum seal for the finished product before embedding
		Delivery information	Check information and statistics on designs they have produced in the past
		Design Kit	Check a test-build request and send a quote to the designer requesting it
		Manufacturing Kit	Receive notifications for newly submitted designs, test-build opportunities, orders for production
		Information and statistics on past orders	
		Amount of money made on each design and for all designs	Reviews/Comments on this design
		Production time for each order	Aggregated Reputation Score based on Reviews/ Ratings (optional feature)

Design & Fabrication Prototype

The Unum Planter

» The Unum Planter was fabricated from 3/8” Clear Plexiglass, parachute chord, and eight 1” plant pots.

Design & Fabrication

Testing the Designer/Maker Relationship

An experience prototype was created of the Unum design and fabrication process to test assumptions about the relationship between designers and makers, and what information and communication was needed for collaborative production.

Audrey Fox designed a planter for laser-cutting in plastic or wood. A design file and bill of materials was produced to guide the making process. I acted as maker, fabricating the product from the provided information. Prototypes were produced in the Parsons Laser Cutting Lab.

Fabricating the Planter

The original design file contained several etched designs that made the fabrication time unrealistic for the prototype process. These designs were later removed to shorten production time.

Laser-cutting machines read Adobe Illustrator files that must be very carefully prepared to communicate properly with the machine software. There were several initial issues with the way the file was prepared and significant prep time was required to make necessary adjustments. Two important insights gained were that color profiles must be very carefully saved so they match up with what the laser cutter recognizes, and that all text must be saved as outlines. If a maker does not have the appropriate fonts, they will not be able to fabricate properly. Saving text as outlines solves for this issues and will be an important requirement for designers moving forward.

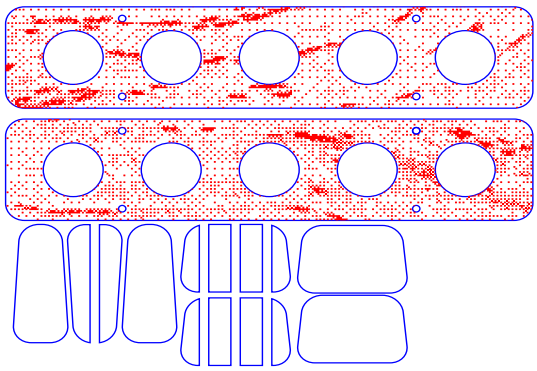
A thin plywood was originally used for a rough prototype but was much too thin and snapped easily. The planter was then redone in 3/16" clear plexiglass which was much more sturdy. The second prototype was also done on a larger and higher-powered machine at the suggestion of the Laser Cutting Lab staff. With these changes, the products could be cut out quickly with no defects.

Through this first fabrication relationship, several important assumptions were tested. Even with a very simple design and widely understood tools, such as the Adobe Suite, mistakes are easily made. Unum will need to solve for this by providing a robust Designer Interface with crystal clear instructions regarding a product's total time on machine, material suggestions, and design file setup and submission guidelines.

BILL OF MATERIALS

Makes 3 Two-Tier Hanging Planters or 2 Three-Tier Hanging planters.

Material	Quantity	Options
White 3/16" Plexiglass	One 18 x 24" Sheet	Can also use Clear Plexi or 3/16 Craft Ply
Black Parachute Cord	One Bag 100 ft	Can also use red cord
Fixed Eye Pulley with ¾" sheave	One	
Tape	1 Roll	Can use copper, electrical, washi, or any other strong tape for securing ends of the cord.



» Planter Design File with Decorative Etches

» Fabricating the Planter on the Laser Cutter

Producing the Manufacturing Toolkit

Given prior interviews with Makerspaces, it was important to understand how much extra information is needed to fabricate a product on demand. While good design files and clear instructions from the designer are important, research showed that the testing and production process for new designs was essential to having them produced on-demand in the future.

In order to understand what information needed to be in the Manufacturing Toolkit, and how much a product would cost if fabricated without it, I took careful notes during the fabrication process. Time spent and material cost was noted for each part of the making process, in order to develop a per-unit-cost of how much a product would cost to be made in a distributed fashion today - without Unum's intervention. Production challenges and suggestions were also recorded to mimic what would be in an actual kit.

The Manufacturing Toolkit

Expenses	
Material Costs	**Labor Costs ($15/hour)**
1 18x24in White 3/16 Plexiglass - $11.00	Fabrication - 30 minutes
3 18x24in Plywood (1/8 In) - $11.00	Cutting Cord - 30 minutes
1 Black 100ft Parachute Cord - $10.00	
1 Red 100ft Parachute Cord - $10.00	
Total = $42.00	Total = $15.00
Per Unit Costs	
Number of Units Produced	**Material/Labor Cost per Unit**
3 Two-Tier Planters Fabricated from plastic	$11.00/3 = $3.66
$11.00/3 = $3.66	$10.00/5 = $2.00
100ft Rope can make 5 Planters	1hr X $15.00 = $15.00
$10.00/5 = $2.00	
30 minutes for fabrication, 30 minutes for finishing.	
1 hour x $15.00 = $15.00	
Total Cost Per Unit = $20.66	
Notes on Prototype Construction & Testing	
Notes on Materials	**Notes on Design**
Fabricated 3 full acrylic planters & 3 full plywood planters (2 tiers each) using laser-cutter. The in plywood was much too thin and easily broke when cutting out. Recommend using bamboo plywood in the future or move up to ½ in plywood. This will take longer to lasercut as it must be gone over several times for the laser to cut through this thickness of wood. Recommend redesigning the planters for CNC fabrication if customization options are to include choices for wood	The original file included several small decorative elements to be etched into the material. This would have bumped up the construction time for each batch of three units to well over 2 hours. Time was spent removing these details for the first testing process. A later batch kept the details in. Given these tests, extra time was spent modifying files and troubleshooting issues with the requested material choices above. Recommended to include less decorative detail on the planter shelves if prices are to be kept low. With no decorations, fabrication will take approximately 30 minutes. With decoration, fabrication will take between 1 and 1.5 hours.

Calculating Testing Fees

Normally the maker would quote a price for testing before prototyping the design, but I took notes on the time spent and potential cost for future reference.

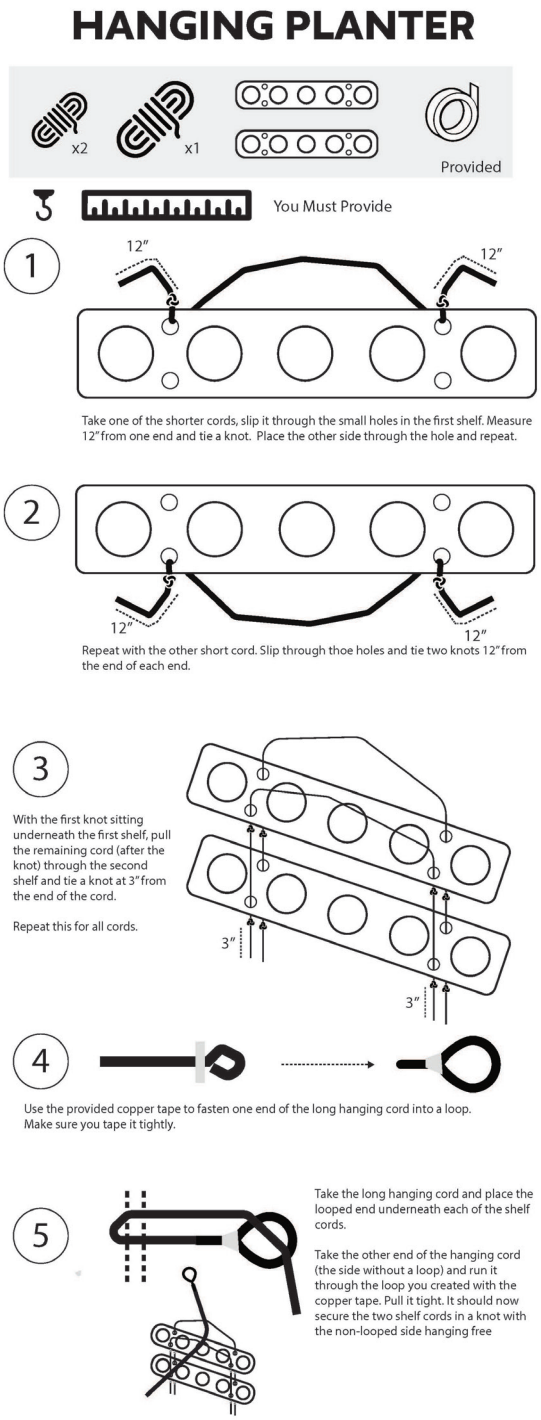
- Fixing Files - 30 Minutes
- Cutting - 3 Hours (issues with cutting the wood, plastic went better and only took 30 minutes to cut out - 2 passes).
- Cutting Parachute Cord to Size - 30 minutes
- Total Time Spent = 4 hours
- Estimated Wage = $25.00/hour (for master maker)

Total Testing Cost = $100.00

Developing Assembly Instructions

After production was complete, a set of instructions was drafted for customers, taking into account the key demographics of anticipated customers and their familiarity assembling furniture/products.

The first round of instructions were written up entirely by hand,. A quick round of user testing showed that they were not understandable and the below graphic instructions were drafted.



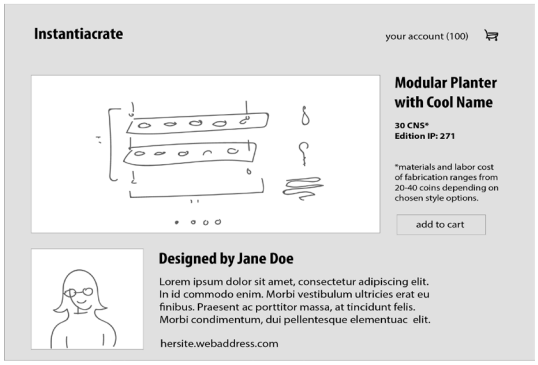
Customer Experience Prototype

Testing the Desirability of the Unum Model

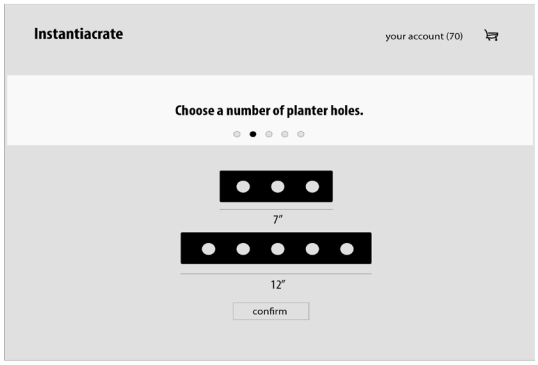
In order to test whether or not Unum represented a service that customers were excited about, a simple wire frame mock-up was created of an Unum web store. This prototype was also used to gauge how well customers understood Unum's process vs. a regular store, as well the clarity and usability of the interface and ordering process. The prototype was run on Marvel.com and tested through a cognitive walk-through evaluation and follow-up qualitative surveys with several students and faculty at Parsons School of Design. Users also received an unassembled planter which they were then able to put together according to the provided instructions.

Key Assumptions to Test with Prototype

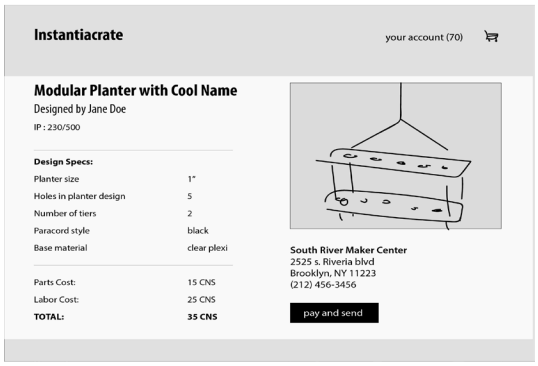
- Could users understand the purchasing model, that they were purchasing a license for an idea, combined with the price of custom material, fabrication, and delivery quoted by a maker?
- How much customization did users want to have?
- What user interface choices could support customization options?
- Did users enjoy the process of receiving their design and assembling it?
- Would user prefer purchasing products and furniture using this platform over traditional retail stores or other platforms?
- How did users resonate with Unum's short pitch articulating the key benefits of the platform and short explanation of how the blockchain protocol supported the solution in a revolutionary new manner?
- Did this experience help users to reimagine the way things could be designed/produced, how value could be exchanged peer to peer, people could collaborate together on designs and projects in the future?



» Home Page



» Customization View



» Check Out & Purchase from Maker

User Testing

User tests were performed with students from Parsons MFADT program. Each user was asked to complete a set of selection, customization, and purchasing tasks on the Unum web store, and then to assemble a planter if they so chose (noting that the price would be higher if purchased assembled). Each user then completed short in person interview.

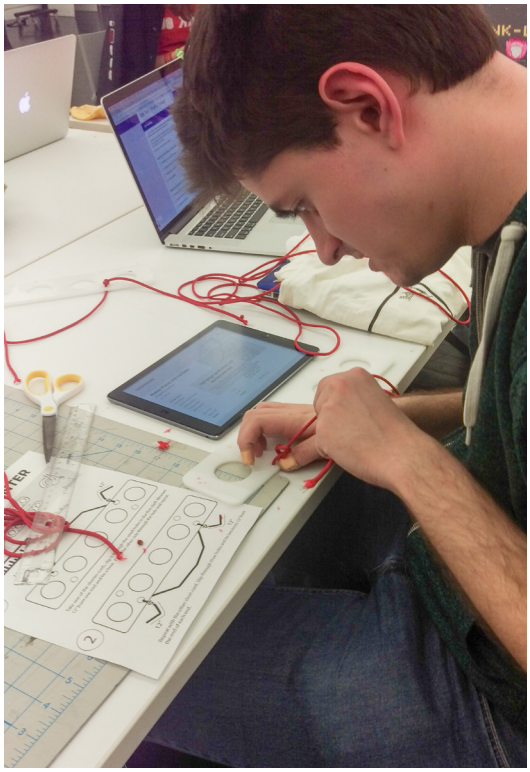
Feedback from Customer Experience Testing

Feedback was collected through online forms and analyzed for insights addressing key assumptions. Below are key insights gained from user testing.

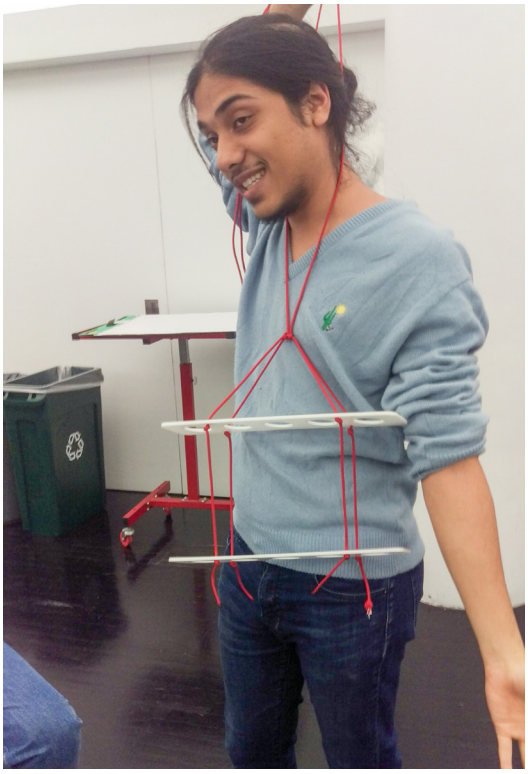
What part of the UI ordering platform did you find most confusing or worrying and what would you want to change?

Exchanging Money for Unum Tokens: Users don't feel comfortable exchanging government issued currency (USD) for in-app tokens at this time. It still seems to foreign a concept and dilutes the understanding of the the blockchain works from the customer point of view. However, adoption in this area is already beginning and some users expressed a metaphorical understanding of the token procedure given their familiarity with online gaming and in-app game currencies. In addition, users expressed they would want a fixed exchange rate (e.g. one-to-one) as it gave them a security around the value of their currency exchange. They had heard of bitcoin fluctuations and it made them uneasy to exchange national currency for a speculative financial instrument.

Unum Web Store UI for Customization: The wire-frame UI felt too static. While understandable, users expressed that they would want to see both the design and price change to reflect their customization options. This would allow them to get the best picture of how the final item would look, given its in an online store, and would help them to make purchasing choices about the quality of materials versus their budget. It was suggested to look at how companies offering customization options work their UI, such as dominoes. Users were split on whether they wanted completely or limited customization options. Those unfamiliar with fabrication wanted to be able to customize to exact specifications, but those familiar with fabrication said they suggested only having a preset menu of choices to work with so maker partners could more easily fabricate on-demand.



» Following instructions to assembled planter



» A completed assembly

Purchasing Process: Users were very confused by the purchasing process, given that the cost of the product was for two things: licensing a copy of the design and paying for chosen custom fabrication options. For the first prototype, two payments were required to take place which users did not like. They unanimously expressed that they would want to first have the option of obtaining the license and choosing all custom options before paying. If an option needed to exist to just license a copy of production for a later date, it should be de-prioritized in the User Interface. Better UI cues must also be given to help customers understand that they are purchasing a licensed copy of a digital file. It was suggested that Unum look into creative commons licensing precedents (or using them if applicable). Users also suggested having a minimum and maximum price on the listing for each product so that they could easily see if it would fit in their budget.

Would you prefer to purchase things in this way in the future?

Users expressed that while they appreciated the intimacy of collaborating with designers and the environmental and community benefits of local production through makers, two things were necessary to make them switch to this type of production. First, there must be a range of designs that meets their tastes and needs. They don't want the products to be something that can just be bought from IKEA, they need to stand out as unique design pieces. Second, price was a huge factor. Users would only want to purchase things in this way if they were more affordable than current local and boutique design companies. If just as expensive as artisanal products, they didn't see the point - especially since the hand-made quality of artisan work would more justify the price increase in their mind - versus something machine fabricated. Users also suggested using local and seasonal materials only available through certain makers in order to give a local artisanal quality to the work and allow unique variations to only be made in certain regions.

Did the ordering experience help you understand value in new ways?

Users stated that the platform did help them to understand value in new ways, however it was not yet clearly communicated through the interface alone - requiring an explanation of how the products were created differently from traditional products. Many users stated that they never thought about production done in this way and it opened up their eyes to new possibilities for consumer goods being more than just something you get, versus collaborate on with people. Users also felt that Unum was a great way to honor the design and the person who thought it up by shifting much of the credit to them, both by featuring them as the progenitor of the product and by compensating them for each copy made. They stated that it would be great if customers could collaborate more directly with the designer in the future to get truly custom made products.

Insights Gained from User Test Observations & Moderation

Several insights were also gleaned from watching users interact with both the Unum web store prototype and try to assemble the planter from instructions. It was determined that the assembly instructions would need to be developed much better as they were currently too confusing. Most users ignored the words completely, so it may be possible to get rid of them in order to make this practical internationally.

Users also kept flipping to the fully diagram of the assembled product (on the back page) instead of following individual instructions. When asked why, they expressed that they wanted a full diagram of the completed object on the first page of the instructions, so they could see what it looked like fully assembled and check their progress. They also said it was better to combine multiple steps into one diagram, especially if actions needed to be repeated (e.g. tying the string the same way on both sides of the planter). Users also had a lot of trouble measuring the cord and tying knots. It might be better to have makers mark the string with chalk or some other removable substance at the suggested lengths for tying the knots, instead of having customers measure themselves.

Some users expressed during the process that they thought it would be much easier to have a video walkthrough of assembling each product hosted right on the Unum web store. This would allow potential customers to see how hard the process was and current customers to have something to watch for help. After both developing the instructions and watching them be used, I think that there should be a way to standardize the instruction submission process from designers/makers so that the Unum team can spend as little time as possible on developing the instructions and getting the product up on the site.

Suggestions for Further Resources & Precedents

Many users had suggestions for other websites, companies, or people who could help inform the customer experience process. Many expressed an opportunity to work with makers upstate who are suffering from the collapse of traditional manufacturing in the US, but who have skills that could make them great partners in this venture. If it is possible to work with a community this could make a real economic impact for, the project will seem stronger from the beginning. The following precedents were also suggested for inspiration and heuristic precedents:

- Lauren Slowik's Thesis on 3d Printing custom mods for IKEA furniture
- 'Make America Great Again' campaign by white house. Re-orienting manufacturing to US towns and cities is one thing both political parties can agree on.
- ApartmentTherapy.com and other sites that offer DIY tips for people living in apartments and small spaces.
- Commercial and Education customers were suggested as other target markets given the speed and quantity of their production needs. needed in their production. as another way to pitch this
- Look for economic and community development initiatives this could be pitched to for grant or public money. Consider the different ways Unum can be explained, a venture, a job training opportunity, an economic development engine etc.
- Look at how maker websites and organizations show tours of the shop, interviews with makers and other tools to personalize the experience for people working in the shop. This could also strengthen a sense of collaboration for customers and get them out to visit the actual maker center, ultimately adopting more of a maker mindset.

Maker Prototype

Fabricating Open-Making Furniture

» The KUKA Chair - Designed by Denis Fuzii, Listed on Opendesk.cc, Fabricated by Dana Martens & Audrey Fox

Building Opendesk Furniture

The early planter prototype focused heavily on the customer experience, relying on a tested design that was easily fabricated using a laser-cutter. The goal of this prototype was to gauge target customers interest in purchasing furniture and homegoods through a distributed manufacturing platform. While this prototype was helpful in testing assumptions about customer's needs, several questions were raised through interviewing makers and designers regarding what information they needed to participate in this type of network and what types of information (files, testing processes, notes) they considered their unique intellectual property that should be compensated.

» The KUKA Lounge Chair by Denis Fuzii

In order to understand these needs, a second prototype was developed with the goal of taking an already open design blueprint from Opendesk and fabricating it as maker. Through this prototype, we addressed several important questions regarding the viability of on-demand manufacturing today and what information might need to be collected and communicated to make it work for Unum's partners.

- How production-ready are files coming from Opendesk and other types of open-manufacturing platforms?
- What types of files does the platform provide, what programs can open those files, and what setup, naming conventions, and notes are included for makers?
- Could the file be fabricated as is, using provided instructions, or is expertise needed to produce them correctly?
- How much time does it take to translate and set up a design file on the proper fabrication machine? How can Unum reduce this time?
- How do material variations, measurement conversions (e.g. metric to imperial), and machine tolerances affect the process? How could these be overcome in the future?

Choosing the Furniture

Opendesk was chosen for this prototype since they are the most well-established open-making and distributed manufacturing platform that exists today. In addition, interviewed maker communicated that their designs were not production-ready, making it a huge hassle to try do produce small quantities of designs for clients. This is why Opendesk focuses on commercial furniture that can be produced in larger batches by partners, versus retail furniture, where a customer might just want one item.

» Flatpack design with no fixtures needed

The KUKA lounge chair[1] was chosen for fabrication given its simplicity, flat-pack friendly design, and its ability to be easily assembled and disassembled by customers, key features Unum would like to include in future furniture and product collections. This chair was designed by Denis Fuzii and shared openly on the Opendesk platform (meaning no fee is required for its download if produced by an individual.

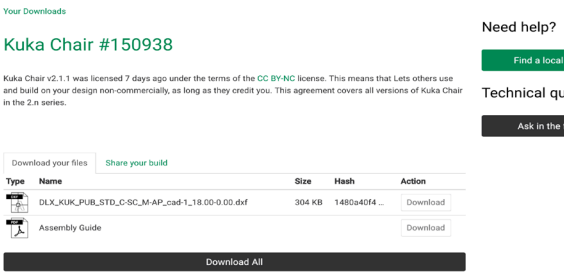
Getting the Design Files

The file was downloaded from Opendesk after filling out mandatory information: Maker Name, Maker Email, Reason for Production. This information was used to generate an on-the-spot Creative Commons license for the chair and to generate a unique product identifier, signaling an instance of the chair had been taken out for production. A link to the design file, license, and an instruction/tip sheet for producing all Opendesk furniture were then emailed, allowing temporary access to the designs through the Opendesk platform. Clicking on this link also automatically an registered the provided name and email on the Opendesk platform, allowing future access to the files.

1 https://www.opendesk.cc/studio-dlux/kuka-chair

Important Features to Consider Moving Forward

Opendesk does a great job of channelling users through the proper licensing channels to receive the files, requiring a name and email for future access, and using this information to auto-generate a creative commons CC by NC 2.0 license for non-commercial use.

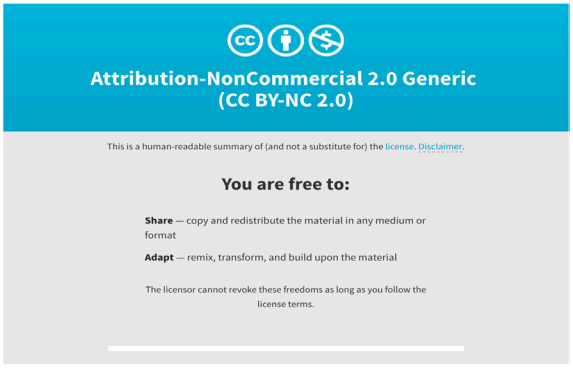


» Opendesk File Download Interface

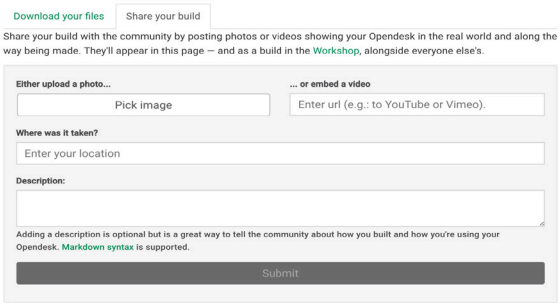
They also have an excellent system for tracking versions of the design, as open-making prioritizes remixing and building upon designs from the beginning. The Kuka chair being prototyped is version 2.1.1 and only that specific version was included in the creative commons license provided. This is reinforced through the provided assembly guide, which is auto-generated with the maker name and license number every time a new download is initiated.

As can be seen in the assembly guide above, Opendesk has a strong sharing and community component, offering a forum where individual makers can ask technical questions and several sharing methods for users to upload their build of the design and distribute it to the larger community (QR code in the assembly guide, and an online sharing interface below).

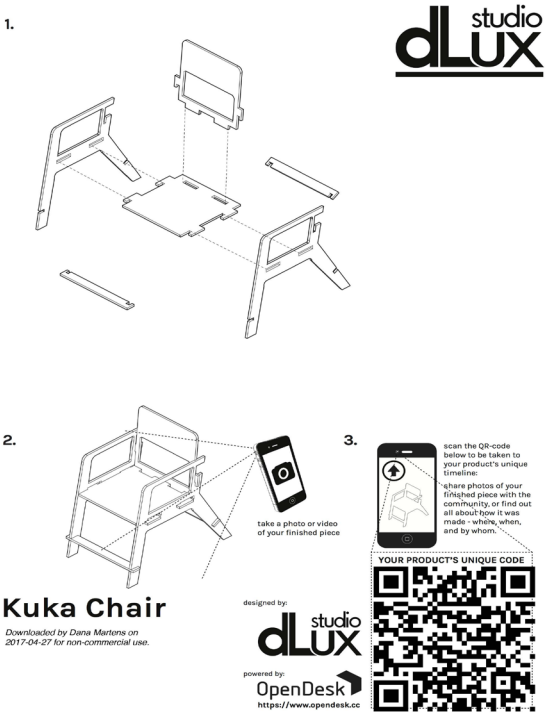
Opendesk additionally makes it very clear that any liability issues that arise from constructing the chair as a personal maker can not be traced back to the original designer nor Opendesk. From a legal standpoint, this precedent is extremely important. In a distributed manufacturing relationship, liability is a big question. Who is responsible if something goes wrong or if a customer gets hurt using the product? Primary research revealed that most professional micro-manufacturers carry liability insurance, taking responsibility if there is a problem with the build, instead of the designer. However, many informal making centers (hacker spaces, small membership-based maker shops) do not carry it, which could be a problem moving forward.



» Creative Commons CC by NC 2.0 License



» Opendesk Sharing Interface



» Kuka Chair Instance Information & Assembly

Problems

However, several problems arose when using the Opendesk interface. While the access link was emailed, it only worked part of the time, and several versions needed to be downloaded to get a working link, resulting in several licenses and versions being generated. Also, the link provided to go back to the page with the files at a later date was not working, making it difficult to re-download the Assembly Guide and production file later in the making process, when using the computers at the making center. It should be noted that once the files are downloaded, there is no way to ensure they are not copied, re-distributed, or uploaded back online, and we were easily able to email them back and forth once we had them, generating several copies of the product instance production file. While this would theoretically be in violation of the CC by NC license, if used commercially, this would be very difficult to track and enforce, especially since anyone can register a fake name and email when downloading the design initially.

Setting Up the Files for Cutting

Once all the proper files were obtained, they were brought to the Parsons Making Center's CNC Shop for review, setup, and production. The file provided by Opendesk was a DXF file which can be opened by several types Autocad software and Adobe Illustrator (see Appendix II).

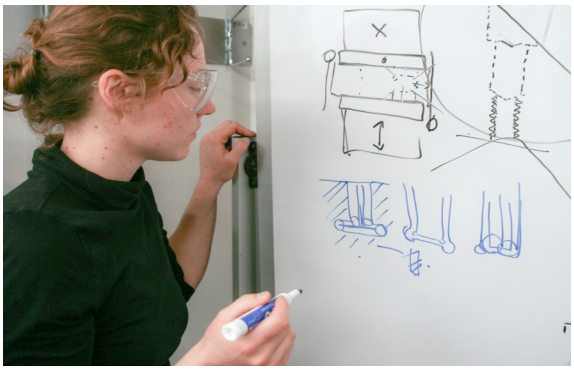
Within this file, each layer was named according to the type of CNC cut the designer suggested, and how deep the CNC drill bit should go for the cut, e.g. 'TOP-POCKET-INSIDE_14MM' which describes a CNC pocketing inside-line cut of depth 14mm from the top surface of the material. Instructions on suggested machine tolerance were also included as well as both back and front cut-lines, in case a product needs to be cut-out from both sides of the material. Opendesk labels all of their products this way and includes extra tips with each file.

All of these conventions were very helpful in getting the chair design production ready, but also had some critical issues, detailed below.

Each chair design also had a shallow circle added where the Unum seal could be inserted post-production. Given difficulty in centering this shape in the already

Problems with Design Files

» Preparing the Files for CNC



» Troubleshooting Instructions from Designers

The biggest problem was that all of Opendesk's designs (since they are UK based) are listed in metric and all suggested materials given in metric dimensions. Luckily, one of the maker center staff assisted us to resize the design according to imperial measurements, by inputting the dimensions for a 4" x 8" Plywood sheet (closest equivalent to material they suggested) and having the Aspire AutoCAD program automatically resize the artwork. This could be a big barrier for Maker unfamiliar with converting between measurement systems. Another issue was the material. Plywood is made from several thin sheets of wood veneer ('plies') that are glued together. The design file listed all cuts as Top Cuts or Up Cut, meaning that the CNC drill bit spins counter-clockwise when cutting, pulling the wood out of the way as it goes. While this works for hardwoods and other materials, it results in tearing or chipping the plywood veneer on the surface layer. The master maker suggested first using a Bottom or Down Cut to etch the design onto the wood. Since the drill spins clockwise it pushes the material down, which won't hurt the veneer. After this first layer is etched, Top Cuts can be used to fully cut the file out. This

messages was reinforced when we looked at other builds of the chair which all seemed to have cracked/flaked surfaces.

In addition, all cuts were suggested as 'Inside Cuts' meaning the CNC drill bit runs on the inside of the lines provided in the file. When we previewed the design in this way, many of cuts seemed too thin and narrow. The master maker suggested we use Inside Cuts only for joinery and parts to be cut out of the middle of the material, not the outside outlines of the chair.

Finally, since the ShopBot CNC machine in the maker center does not have a vacuum hold-down system (which holds the plywood tight to the CNC bed) we also had to include several tabs in the design file to keep the material together when cutting. These tabs needed to be added along almost every cut-line to ensure nothing wobbles when the machine is running. After the machine is finished, a router is used to cut through these tabs and free the pieces from the material. They then all need to be sanded down during finishing.

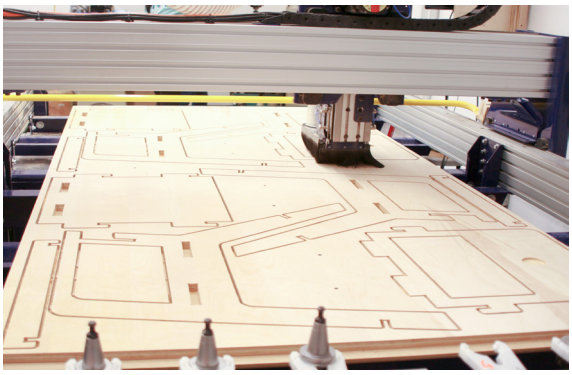
All together, the file setup and review with master maker took over 5 hours, given all of the adjustments that needed to be made. It became immediately apparent why interviewed makers stated that these types of files could not be produced on-demand in a profitable way. Without the ability to share this important information, every maker would have to spend significant time making decisions about the best way to fabricate the chair, given that the suggestions provided don't lead to a well-fabricated product. At a reasonable rate of $15.00/hour, this would add over $75.00 to the cost of every product in labor time, making it unaffordable for many customers.

Fabricating the Chair

After all the setup time was complete, a 4" x 8" sheet of 3/4 inch Canadian Plywood was purchased from the Maker Centers shop for $60.00. This sheet can fit two full chairs designs meaning each chair costs $30.00 in materials to produce. The wood was measured using a digital caliper to correct for any inconsistencies in material depth that would need to be accounted for on the CNC Shopbot Machine.

Since the machine does not have the vacuum hold-down system, we were also required to screw the plywood into the machine bed. Before the initial etching cuts, we attached the four corners using screws. After it was clear where the cuts would be made, we could then use an additional six screws to hold down the material in the middle.

After the fabrication was complete, the material was moved off the bed and a hand-router was used to cut through all of the tabs and free the chair pieces from the material. The total machine time for the chair fabrication (including tool changes for the etching down



» The Shopbot cutting out the Kuka Chair

cut and the cutting up cut, and screwing down the wood) took just over three hours. At a rate of $15.00/hour, the labor cost for the product would be $45.00 for initial fabrication.

Finishing & Assembly

The chairs were finished by using sandpaper to smooth off all tab edges and stained to a dark brown color for exhibition. Given the design of the KUKA chair, no additional screws, bolts, or fixtures were needed as all pieces snap together.

» The KUKA Lounge Chair by Denis Fuzii

Final Insights from Prototyping

» Sanding the Chair Pieces

This prototype was extremely helpful in understanding why on-demand production isn't currently possible for makers. Many people assume that fabrication is a lot like printing. The design blueprint is just loaded into a machine and comes out perfect. This is clearly not the case. All together, over 8 hours were needed to setup the file properly for the machine, properly secure materials, make adjustments and tool changes, and cut out the final product from the tabs by hand. In

» Using a Palm Sander from the Maker Center

addition, master makers provided invaluable insights into the best way to cut out the products, moving away from the suggestions made in the file significantly. Its no wonder makers consider this time and adjustments, their Manufacturing Kit, as valuable intellectual property that they should be compensated for. They would need all of this information each time they produced the chair in order for it to be made quickly and well on-demand. Right now, trying to do this for individual products would push labor costs much too high, meaning the maker isn't being compensated enough for production or that the price becomes unaffordable. No distributed manufacturing platform takes this into account today meaning that Unum has an important strategic advantage over competitors in this area. By using the blockchain to allow certain maker to prototype designs, Unum can compensate them for their unique manufacturing insights every time the chair is fabricated in the future. This solution both incentivizes makers to test products and share essential manufacturing information that is needed to truly fabricate goods on demand in a profitable and affordable way.

Final Build

Both chairs will be exhibited for thesis as a demonstration of how distributed manufacturing can work using the Unum model.

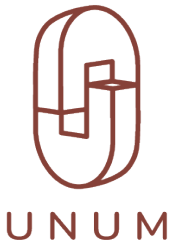
» The KUKA Lounge Chair by Denis Fuzii

Business Prototyping

Developing the Unum Business Model

In order to understand how Unum would work as a venture, significant time was also spent researching and sketching out Unum as a business model. This process included market and competitor research, the development of a potential business structure and revenue model, and writing a value-proposition for Unum as a startup venture. This information is vital in moving forward with Unum as a viable business opportunity and raising funding in the future.

The Blockchain for the Makers Movement



What is Unum?

Unum is a distributed manufacturing platform and web store that uses blockchain technology to connect makers, designers, and customers in trusted peer-to-peer relationships, without intermediaries.

We envision a future where products of all types can be created through blockchain based distributed manufacturing networks that support more sustainable, transparent and community driven production. Our mission is to take the first steps along this pathway and create a blockchain-based distributed application (d'app) that uses smart contracts to coordinate the unique intellectual property and compensation needs of designers and makers.

In order to demonstrate Unum's potential for systemic impact, and recruit initial maker partners, we are also creating a proof-of-concept Unum web store to sell parametric and flat-pack CNC furniture and organizational units (shelves, desk accessories, plant holders etc.) designed by up-and-coming student product and industrial designers at Parsons School of Design, facilitated through the Unum d'app, and produced at The Parsons Making Center.

Who is Unum for?

Overall, Unum has three primary audiences with very different needs, designers, makers, and customers. Unum also benefits communities.

Designers

Unum's primary audience is new and upcoming designers who are creating affordable and parametric designs for digital fabrication and are not exclusively attached to design studios or retail factories. The Unum blockchain d'app can eventually support any design that can be fabricated through a combination of CNC routers, laser-cutters, and 3D printers. However, due to initial research insights and testing, the first focus will be placed on recruiting design partners that are working on CNC furniture and home organization units that have a low surface to edge ratio, meaning that they require little finishing. Unum also prioritizes parametric designs, made from sustainable and recyclable materials, that have few fixtures (screws, bolts etc.) allowing finished products to be flat-packed, shipped to, and easily assembled and disassembled

by customers, supporting modern urban lifestyles that find people moving frequently.

Product/industrial design students and faculty at Parsons School of Design will be recruited for initial public beta tests of the Unum platform.

Makers

Our primary maker audience is micro-manufacturers, fabrication labs, and makerspaces who have enough machines - or space and budget for new machines - to handle increased production demands from joining the Unum platform and are open to adopting their existing business model to include distributed manufacturing activities. One early research insight was that there are big differences in the manufacturing capability and organizational mindsets of different types of maker spaces such as hackerspaces, fabrication labs (fablabs), maker centers, and micro-manufacturers. Many hackerspaces and maker centers have a more educational and community-oriented mindset and aren't interested in acting as manufacturers at the organizational level. However, most of these organizations are member-driven and would allow maker members to join the Unum network and use the facilities produce products.

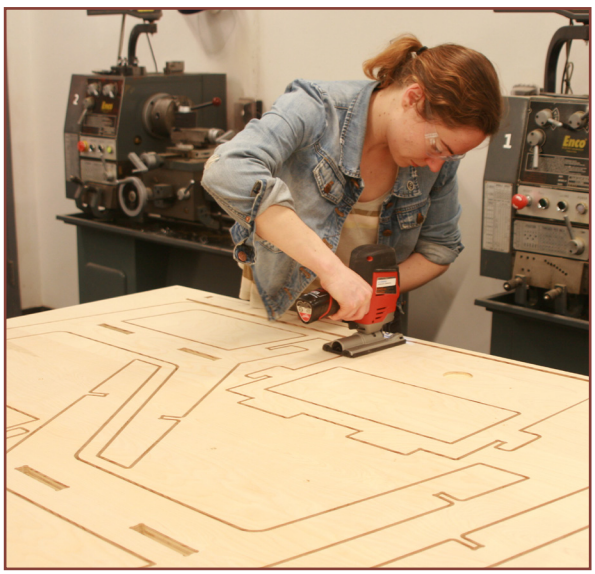
Initial research has also shown that several NYC-based maker spaces may be inappropriate recruits for initial implementation, given the price of real estate in many areas of the city, which limits facility size, machine allowances, and opportunities for expansion. In addition, many urban makers have already established lucrative business models that fully utilize the space for paying members and walk-in machine rentals. Demand for machine time seems to be high enough in major urban centers that makerspaces aren't interested trying out new and untested revenue lines, unless they can be conclusively proven to be more profitable than current business models. As a result conversations are being arranged with makers in the outer-boroughs of New York City, especially those located in Industrial Business Zones (IBZs) who can leverage city-sponsored tax-credits and direct business assistance from city agencies to support new business opportunities, as well as those located in Mixed Use Districts (MX) are allowed to co-locate a retail showroom on site and sell products directly from the shop.

Dana Martens and Audrey fox will initially act as makers, working out of the Parsons Making Center for initial public beta tests of the Unum platform. A third teammate with significant experience using digital fabrication tools, specifically CNC routers will be recruited to assist.

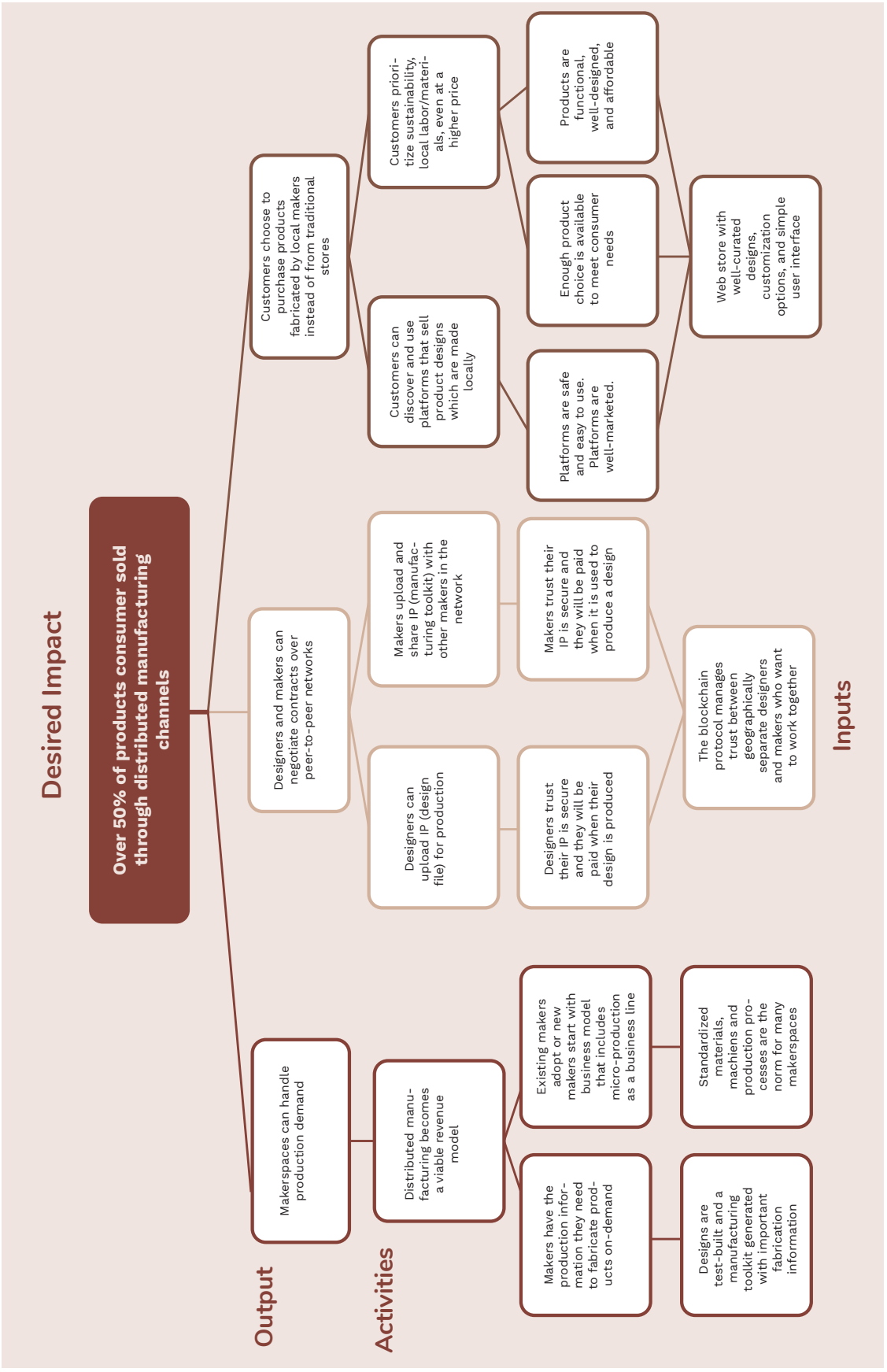
Customers

Target customers are NYC residents of any gender or ethnicity who make between $40,000 and $100,000 annually, rather they have a high enough income for the area to afford new furniture and home goods, but not enough money to access products from designer brands and specialized design studios such as Design Within Reach. For this reason, Unum is primarily focusing on older Millennials and younger Gen-Xers aged roughly between 25 and 40. Our research has shown that people in this age group are community and civic minded, tech-savvy, and prioritize authentic and responsibly-manufactured products. Initially, designs will be curated on the Unum web store to meet the purchasing behavior and paint points of this target segment, who typically live in small apartments and move often as they become established in their careers .Meeting the needs of these specific customers as well as the limitations of digitally fabricated products has informed our choice of design aesthetics, product features, and material choices for early implementation efforts as outlined above.

This target customer segment will be the focus of initial public beta tests of the Unum platform and the model will be adjusted accordingly as new insights are gained. All new customers will be interviewed about the selection and quality of designs available and what they would like to see more of.



Theory of Change



Theory of Change

Since Unum represents a system-level design intervention, a Theory of Change was drafted to backwards map how Unum's design inputs would generate the necessary outputs and activities to reach desired impact. This model represents the steps needed to achieve a competitive distributed manufacturing system and how Unum is positioned to begin that process through its core business activities and social mission.

Value Proposition

Unum | The Blockchain for the Maker's Movement

Unum is building the first viable electronic infrastructure to coordinate trusted peer-to-peer business relationships between designers and makers while giving customers complete transparency into their product's origin and manufacturing lifecycle. Unum leverages the emerging blockchain protocol to facilitate this trust by encoding each party's terms and conditions into smart contracts that create and manage all transactions along a unique digital manufacturing thread for every physical product instance fabricated from a digital design. This thread is immutably tied to the finished product through Unum's proprietary NFC-based seals, which are embedded and activated by makers during production, allowing customers to own a verified physical copy of a digital idea, forever.

Unum provides several unique benefits to designers, makers and customers with the blockchain providing a unique value-add for each audience. Through helping these stakeholders, Unum also benefits communities.

Designers

- Allows designers to leverage an online global distribution channel for products that can be manufactured anywhere with digital fabrication tools.
- Helps designers get their products to market even if they don't have the initial capital or facilities to manufacture it themselves.
- Enables multiple designers to collaborate on one design and each be compensated for their contribution.
- Can eventually coordinate the modification or remixing of designs where each new version created and sold pays-out all contributors back to the original designer.

How the Blockchain Adds Value

The blockchain allows designers to be automatically compensated each time an instance of their design is purchased and securely manages their intellectual property by creating an immutable record every time a design file it is checked out by a maker for production. Unum's embedded seal acts as a digital/physical bridge that verifies the product is a 'licensed' copy that can be scanned to show the designers information.

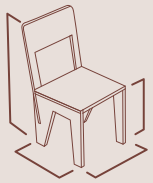
Makers

- Provides a new revenue line for existing maker centers and a unique business model that can help more maker centers open shop with a guaranteed sales pipeline.
- Compensates makers who test product builds and create/share digital manufacturing kits by paying them a testing fee each time the product is fabricated in the future.
- Makes it practical and profitable to produce digitally fabricated products on-demand within a set range of customization options.

How the Blockchain Adds Value

The blockchain allows makerspaces of all kinds to profitably participate in distributed manufacturing networks. Smart contracts automatically coordinate terms and conditions between designers and makers, verifying the identity and transaction history of each party's intellectual property assets. Makers can now share a common database of tested production processes - manufacturing kits - that allow products to truly be fabricated on-demand with minimal setup time and adjustment. Makers are incentivized to create and share this valuable intellectual property since they are compensated whenever it is used in future builds.

Stakeholders



DESIGNERS

~ Leverage online global distribution channel

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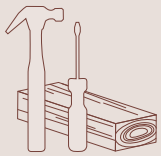

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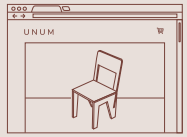

CUSTOMERS

~ Provides access to globally designed products that can be mode locally.

~ Supports authentic, quality and responsibly manufactured products that are affordable for a wider variety of consumers.

~ Makes a product's life-cycle transparent, allowing customers to make informed decisions.

~ Helps customers be more aware of the economic consequences of their consumer choices.

COMMUNITY

~ Creates new opportunities for local and regional circular economies to compete with massive, global and corporate-owned economies of scale.

~Helps to keep local money circulating in the local economy.

~ Offers enriching and lucrative employment opportunities which pay well over minimum wage and provide important 21st century job skills.

Customers

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- Supports authentic, quality and responsibly manufactured products that are affordable for a wider variety of consumers.
- Makes a product's lifecycle transparent, allowing customers to make informed decisions
- Helps customers be more aware of the economic consequences of their consumer choices.

How the Blockchain Adds Value

Combined with Unum's NFC-enabled seal, the blockchain allows consumers to trust where their products came from, what materials were used, who designed them, who fabricated them, and how it got to them.

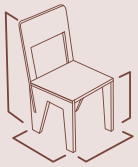
Community Impact

By prioritizing on-demand production located around customers, Unum creates new opportunities for local and regional circular economies to compete with massive, global and corporate-owned economies of scale. Since customers can have globally-sourced designs made locally, Unum allows for consumer choice while circulating rather than extracting the value of their economic activity, keeping local money local. They also offer new lucrative employment opportunities. Many existing makerspaces who want to join Unum will need to hire new staff to meet increased production demands and spaces who open with Unum in mind will require employees from the start. Digital fabrication jobs such as CNC operators typically pay well over minimum wage and provide important 21st century job skills that can both be transferred elsewhere, or allow employees to open their own shops down the line.

In addition, makerspaces have already become important community assets, helping entrepreneurs prototype new ideas and ventures, educating people on how to use digital design and fabrication tools, and cultivating a maker mindset which empowers more people to create their own solutions to local challenges and meet community needs. By providing a secure and scalable way for existing makerspaces to grow and new makerspaces to open, Unum supports a virtuous cycle of economic democracy and community prosperity that re-orients the monetary and cultural value of production and keeps money flowing through circular economics at the local and regional level.

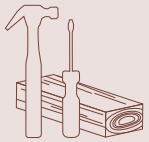
How Unum Works

HOW UNUM WORKS



DESIGNED FILES

Designer uploads their work and approves a bid for the production of a manufacturing kit.

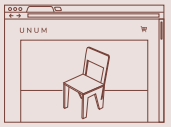


MANUFACTURING KIT

Selected shop test builds a prototype and creates the guidelines for design production.

MAKING CENTER

Contracted Maker produces the item with a time stamped access to the manufacturing kit.



WEB PLATFORM

The design is available for sale. Unum connects buyers to making spaces.

How Unum Works

Unum involves two main types of transactions between stakeholders. Below is a step-by-step explanation of how it's different technical components work together to manage trusted exchange of digital assets.

Submitting, Testing & Approving Designs

1. A designer uploads a design kit including the design file, bill of materials and production information through the Unum online portal.
2. A smart contract is created on the Unum blockchain d'app time-stamping the submission and recording the designer as the owner of the particular design.
3. The smart contract triggers an email notification to be sent to maker partners with the necessary fabrication tools and who have indicated they would like to test designs.
4. Chosen maker centers can use the Unum online portal to access their Maker Dashboard and access the design kit information.
5. They can either decline testing, indicating why, or prepare a quote and estimated timeline for testing and submit their response through the Maker Dashboard.
6. Designers receive an email notification for every test quote makers send and can access the quote information through their Design Dashboard.
7. If all makers decline testing, the Unum staff will examine the reasons why and contact the designer to discuss options for improving the design or why it won't work for the platform.
8. The designer exchanges USD for Unum Tokens that can be used to conduct transactions with makers.
9. The designer uses the Design Dashboard to select a maker for testing. The quotes' USD amount is transferred one-to-one into Unum Tokens, and the smart contract deducts the value from the Designers wallet, holding the money in escrow.
10. The selected maker produces a test-build for the design in all customization options, using the maker Dashboard to fill out a Manufacturing Kit with information about the fabrication and finishing process as well as machine specific considerations.
11. The maker ships the test-builds in a pre-paid envelope to the Unum team so that they can take product photos for the Unum web store and check the design quality.
12. If the Unum team approves the design, they use the Unum web platform to indicate their approval, and the Unum Tokens stored in escrow are sent to the maker partner. If there is a problem with the test-builds, the Unum team will coordinate with the maker and designer to get it production ready. If the test-build for the design is somehow unsatisfactory, the designer will receive their manufacturing kit for free and the Unum Tokens will be transferred to the testing Mmaker to compensate for time and labor.
13. The Unum team will list the design on the Unum web platform, curating it into the appropriate category and collection.

Purchasing a Design from the Unum Web Store

1. A customer selects the design they would like to have fabricated from the Unum web store and enters their zip code to see what maker partners are nearby.
2. They select their customization options, the price changing to reflect their choices.
3. The customer pays for the design with a credit card or cryptocurrency such as bitcoin.
4. The customer can either choose to save the design for later or have it fabricated at nearest maker partners. If they choose to have it fabricated now, they will have a choice to decide whether they want it unassembled or assembled and if they will pick it up or have it delivered. They can they pay these additional maker specific fees via credit card or cryptocurrency.
5. When the customer indicates they would like the design fabricated, a smart contract is created on the Unum blockchain d'app that records a pseudonymous id for the customer and the customization options they chose.
6. The smart contract notifies the selected maker is notified via email that they have a new production request.

7. The maker uses the Maker Dashboard to examine the request and check out the design kit and manufacturing kit for the product.
8. The smart contract allows the maker one week to access the design information, time-stamping each time it is checked out.
9. The maker produces the product using the information in the design kit and manufacturing kit, recording any machine specific adjustments or suggestions for the process through the Maker Dashboard.
10. The maker scans an Unum seal, connecting the physical product to the digital design thread stored on the Unum blockchain D'App. They embed it in the assembled product or include it with an unassembled product.
11. Either the customer picks the product up and approves receipt or the maker ships the product to the customer requesting that they use the Unum web portal to send a proof of delivery.
12. When proof of receipt is confirmed, the designer, testing maker and producing maker are all paid a pre-agreed upon amount in Unum tokens.
13. When the customers payment is processed, the Unum team exchanges the money one-to-one into Unum tokens to cover the amount spent.
14. If the customer has an NFC compatible device (android smart phone, computer NFC reader) they can scan the Unum seal to see information about the Designer, Maker, license information, how many times it was produced, and in the future, the origin of the materials in the product.
15. Every time the seal is scanned, a request is made to the Unum portal over the internet. This request sends the unique identifier of the Unum seal to the Unum portal, which triggers a request to the product's' specific smart contract for information. The unique identifier unlocks the information displays it on a mobile-ready website for the customer to view.

Market Opportunity

Unum leverages a unique market opportunity that capitalizes on the convergence of several trends in the consumer goods, manufacturing, and technology sectors. Through the domain research and competitive analysis of precedents described above, I have identified several Intersecting opportunities and challenges and designed Unum as a systems-level strategy to disrupt traditional manufacturing practices with the specific goal of providing a revolutionary solution to the key challenges that make distributed manufacturing unrealistic, unprofitable, and uncompetitive in today's economy and digital environment.

Consumer Goods | A Rising Desire for Sustainable Products

- A 2015 Cone Communications/Ebiquity Global CSR Study revealed that 90% of customers expect companies to operate responsibly and address social and environmental issues.
- The same study also found that 84% of global consumers seek out responsible products whenever possible, with 81% citing the availability of these types of products as the larger barrier to not purchasing more.
- A Nielsen global online study from 2015 revealed that Millennials (our target customer segment) are the most willing to pay extra money for sustainable product offerings at 75% of respondents interviewed, and up from only 50% in 2014.

Millennials & The Demands of the Modern Lifestyle

- The Consumer Buying Trends Survey estimated that millennial have become the largest consumer group in the United States for furniture, accounting for 37% of the market in 2014.
- "Because millennials are delaying home ownership, they often look for smaller, multifunctional and affordable furniture that fits into their dynamic and urban lifestyles."
- Millennials are characterized as desiring to differentiate themselves from their peers, wanting to show off their own individuality.
- Millennials are skilled at using technology, more trusting of online stores, and more comfortable buying things with digital devices than older generations. As a result, e-commerce accounted for 21% of total furniture sales in 2014 and is predicted to grow to 30% by 2018, according to research firm eMarketer.
- Recent trends support this forecast, with online sales from the three largest online furniture retailers, Overstock.com, Amazon, and Wayfair growing by 14.8%, 19.5%, and 44.0% respectively.

Manufacturing

The Decentralization of Manufacturing & the Rise of Peer to Peer Online Distribution Channels

- A 2015 SAP report predicts that the 3D printing market will quadruple its sales to $12 Billion by 2025.
- As 3D printing accelerates and comes down in price, more and more goods that once relied on economies of scale driven by centralized factories will be produced at or near their point of use.
- Etsy, a peer-to-peer e-commerce saw it revenue nearly quadruple from $525 million in 2011 to $1.9 billion in 2014.
- It is predicted that the proliferation of digital design and fabrication tools will cause companies to shift their main business activities away from designing, manufacturing, and delivering products to designing and delivering intellectual property that people can use to create their own products or send out for fabrication. Gartner forecasts that 3D printed items will result in the loss of at least $100 billion per year in IP globally by 2018 and that as IP grows in value, it will become an enormous target by companies.
- As this demand for physical products drops and customers fabricate what is needed, the data to create the products will become a licensable commodity. Companies may find it more profitable to license digital blueprints instead of selling products, leading to major shifts in business models.
- As demand for physical products drops and customers 3D print what they need, the data needed to make such products will become a licensable commodity. Companies may find that it is more profitable to license digital blueprints of products instead of the products themselves. This could lead to major shifts in business models, as companies morph from making and selling things to selling or licensing data.
- With a more distributed, local, and real-time supply chain, companies will need to adopt new standards focused on quality, traceability and sustainability.

The Rapid Growth of the Maker Movement

- A 2015 press release on the First White House Makers Faire stated that new digital tools that democratize production are boosting innovation and entrepreneurship in manufacturing, similarly to how the Internet and cloud-computing lowered barriers to entry for digital startups, creating new the foundation for new products and processes that can help revitalize American Manufacturing.
- The first San Francisco MakerFaire in 2006 attracted only 65,000 participants, the 2014 event attracted 130,000 with another 85,000 joining a partner event in New York.
- A 2012 report by the Craft & Hobby association estimated that 62.5 million Americans had taken part in one or more crafting activities in the last year.
- The Atmel Corporation has calculated that there are approximately 135 million adult Makers in the United States, representing 57% of the American population over 18.

Emerging Blockchain Technology Solutions

A Tremendous Opportunity for Extreme Social, Economic & Technological Disruption

- Gartner predicts that a blockchain based business will be worth $10 billion by 2022 and that while development is still immature, the technology can start to deliver value with the potential for extreme societal, business and technological disruption.
- By 2020, new business models will emerge based on smart contracts and blockchain efficiencies.
- In 2014 and 2015, more than $1 billion of venture capital was placed in the emerging blockchain ecosystem and the rate of investment is almost doubling annually.
- The blockchain is becoming a symbol of the ‘fourth industrial revolution’ a term coined by Davos founder Klaus Schwab referring to the deep digital transformation that is now upon us.
- A Cognizant report published in June 2016 cited that the next 12-18 months will be extremely important for companies looking to develop blockchain strategies.

Blockchains, The Maker Movement & Distributed Manufacturing

- The Industrial revolution gave way to a knowledge revolution and shift to a knowledge economy. This economy is again shape-shifting and the Maker Movement is central to that shift. At the heart of this movement is collaboration. The blockchain offers a cheap, shared resource that has the potential to distributed making, creating a true Sharing Economy, spurred by the Maker Movement.
- The blockchain offers enhanced transparency, greater scalability, better security and increased innovation for manufacturing supply chains.
- Using the blockchain to facilitate supply circles could significantly improve upon the already existing goals and priorities of communities and corporations, creating a new standard for local and global marketplaces. Its ability to manage identity and reputation, payments and financial tools, and smart contract supported governance will lay the foundation for supply circles, incentivizing and rewarding prosumers who behave ethically and sustainably.
- "The immediate and low-cost assurance of trust provided by blockchain technology can unleash disruptive innovation by allowing any supplier and any manufacturer to instantly find one another and begin a trading relationship."

Given these converging trends, Unum is well-positioned to raise funds and gain market share by addressing the unique and time-sensitive market opportunity for blockchain based start-ups and ventures to create innovative new methods for managing trust and intellectual property across a distributed manufacturing network anchored in the rise of the makers movement. In addition, the growing demand for sustainable and responsibly manufactured products from Unum's target market creates a high potential for sales. Paired with relatively low initial investment costs (since we will not need to buy any physical equipment, or initially rent office and production space), this sales potential and quickly be turned into allowing Unum to quickly become financially sustainable as it builds its reach and impact.

Business Model

Unum consists of two separate businesses, the Unum blockchain d'app and the Unum web store. The goal of Unum overall is to operate as a 'thin platform' that has a little control over the relationships between makers and designers as possible. The role of Unum is twofold: to curate and promote designs through the Unum web store, and to intervene in any contractual disputes between designers and makers using the Unum Blockchain D'App.

The Unum Blockchain D'App

I am researching how the Unum Blockchain D'App can be registered as an incorporated Worker cooperative in New York State, given the unique possibilities of the blockchain investment model. When maker partners are recruited, they can potentially be employed by this organization, making them co-owners of the business. Maker partners and their dedicated employees working on Unum orders can be allowed to vote to elect a board of directors when enough partners have joined the system, and eventually gain additional participation in the management of the firm.

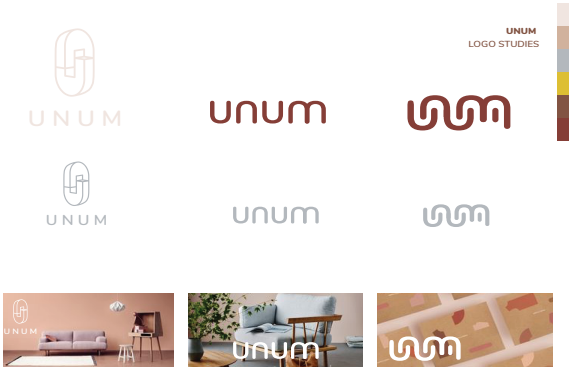
Instead of distributing additional profits through this structure, employees will be given Unum Investment Tokens, which will be a speculative financial instrument the changes in value with its demand. These employees also act as the miners in Unum's blockchain d'app, approving transactions through proof of stake consensus algorithm. Owners of Unum Investment Tokens can exchange them on cryptocurrency exchange sites for their current value in any major national currency.

The Unum Web Store

The Unum web store will be set up as a private company owned directly by Unum's founders and registered as an LLC or S-Corp in New York State (I am also looking into B-Corps and L3C's). Any employees Unum hires directly will be employed by this company and paid in standard USD.

Revenue Model

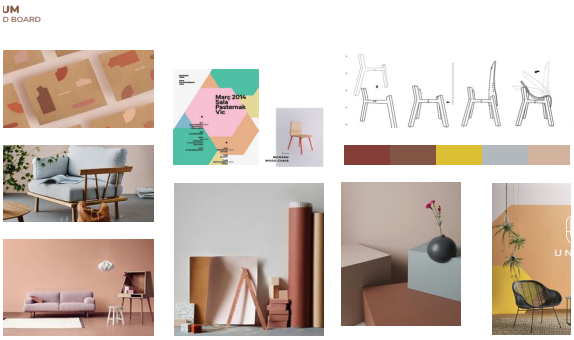
Unum will earn money in two ways. It will collect a transaction fee on all purchases made and coordinated through the Unum blockchain. This transaction fee will be deducted in USD before the customer payment is translated into Unum Tokens. The company will also earn passive investment through our majority share of Unum Investment Tokens. As the value of Unum as a company rises, the value of the Unum Investment Tokens will also rise. These tokens can be exchanged for national currencies on a cryptocurrency exchange.



» Unum Logo Studies

Branding

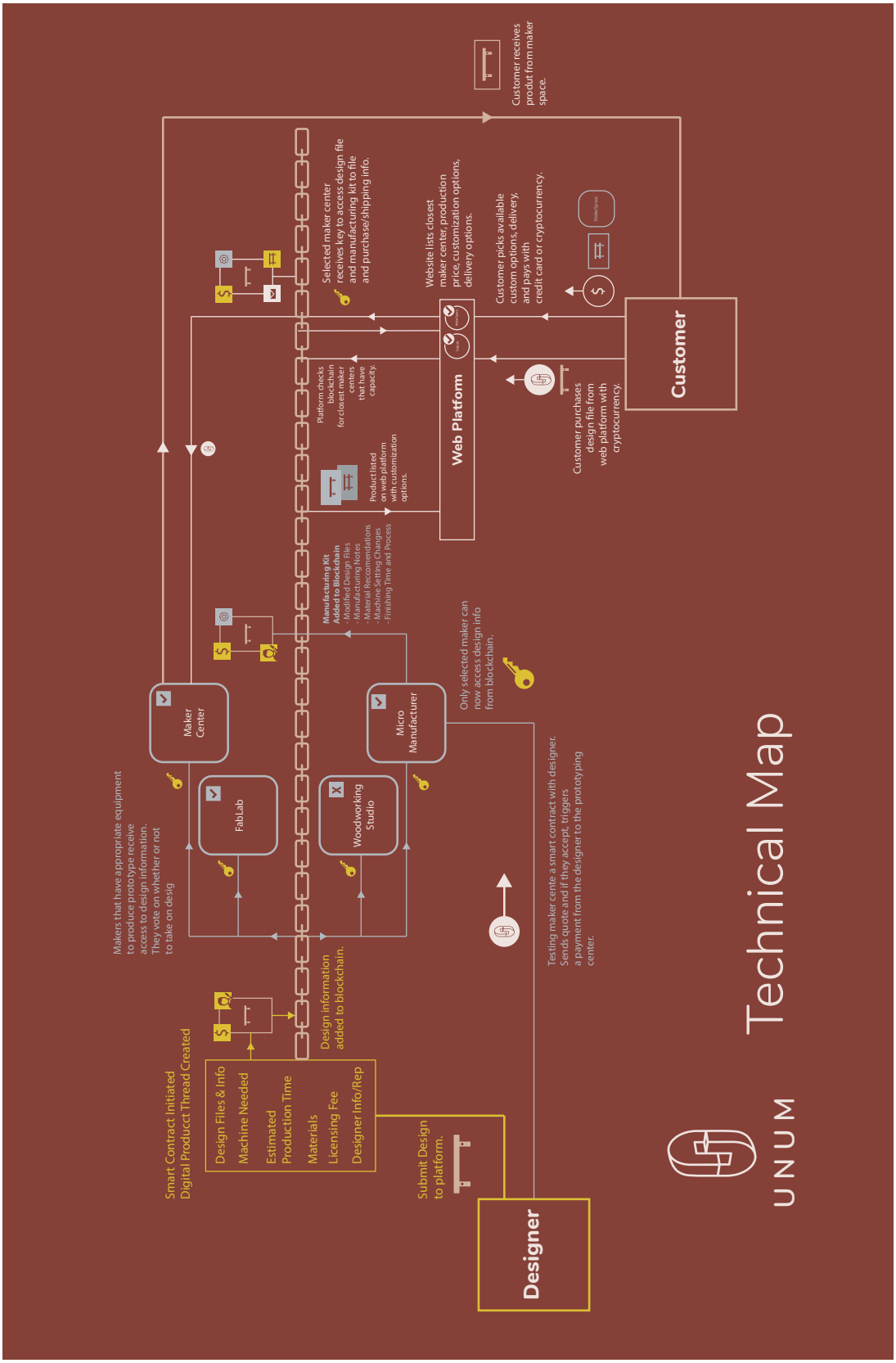
A Pinterest was used to collect images from similar brands and types of design that inspired the Unum Style. A mood board was created by Audrey Fox which helped her to develop brandin assets including a color palette, logos, and layout precedents for the Unum web store.



» Unum Mood Board

» The KUKA Lounge Chair by Denis Fuzii

Technical Map



Technology Prototyping

Mapping & Testing Technical Features

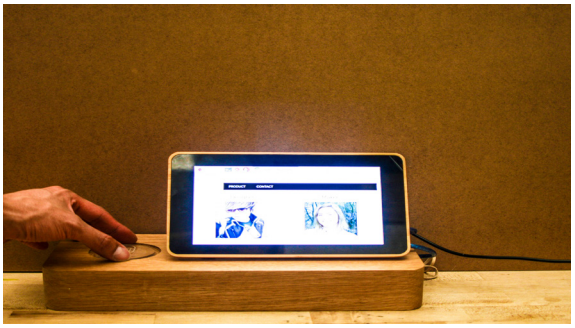
Technical Map

The Technical Map provides an overview of how the Unum d'app and webstore work together to coordinate designers, makers, and customers using the blockchain protocol. When designers upload a file, it is sent to the maker network for review. A maker is chosen to test build the product and coordinates a quote with the designer. Once the design is tested, the Unum team lists it on the webstore. Every time a customer purchases a copy of this design in the future, the Unum d'app creates a new instance on the blockchain using smart contracts. Every transaction for this instance is saved to the blockchain, providing a transparent and immutable record of the product's lifecycle.

The Unum Seal

The Unum Seal is an embedded tag that is inserted into goods made through the Unum platform. The seal uses NFC technology to connect the physical good with the digital manufacturing thread stored on Unum's blockchain d'app. The seal serves as a proof of ownership for the customer, and allows future re-fabrication, recycling, sale, or trade of the product.

The Unum Seal can be read with NFC enabled android phones and will soon also be accessible by iPhones through the next operating system update. The Unum Seal can also be read with standard NFC readers sold online. Each maker will be issued hardware to attach the NFC tag to the Unum seal and attach it to the unique product record of a finished build.



» Seal Demonstration

» Test Seals

» Final Unum Seal

Evaluation

Further Implementation, Reflections on Process

Further Implementation Plans

Moving Forward

Progress is currently being made on a full-system experience prototype of all front-end touch points for the Unum Platform (web store, Design Dashboard, Maker Dashboard, Unum seals). System tests are being arranged with several partners:

- Designers from the BFA Product Design and MFA Industrial Design programs at Parsons School of Design
- Maker staff in the Parsons Maker Center
- Customers recruited through an online survey and can test the web interface remotely or on-site in New York.

This experience prototype will be completed using furniture designs from AtFab, who has given Unum permission to use and modify their designs for testing. Throughout this process, designs and style guidelines will be developed to inform the curation of the Unum webstore. In addition, student, faculty and alumni designers who meet Unum's design aesthetic and who are working with CNC furniture and organizational units will be recruited to curate an initial collection for the Unum web store.

If the next round of user tests goes well and fundraising is possible, the next stage of implementation will be to recruit a blockchain developer to develop the blockchain d'app and smart contracts necessary to coordinate the relationships between designers and makers. In addition, we are applying to competitions, incubators and accelerators who can offer funding and resources to help drive the project forward.

Fundraising Opportunities

To date, Unum has been unfunded. In order to develop Unum as a venture, funding must be obtained to develop two more rounds of prototyping with the goal of having a fully testable experience prototype with the blockchain in place by the first quarter of 2018.

Community Fundraising

There are several opportunities to raise funds through online crowdfunding platforms such as Kickstarter, in return for pre-sales of products. Opportunities within both the Parsons and NYC entrepreneurial ecosystems are also being explored.

- Buckminster Fuller - Grant of $100,000 for ideas/ventures creating system-level impact - Unum has already applied to this competition.
- NYC Media Lab Combine - Grant of $25,000 for high potential media/technology concepts
- Future Cities Accelerator, The Rockefeller Foundation & Unreasonable Institute - $100,000 grant for early-stage organizations with the potential to create deep and lasting impact for vulnerable US populations at scale
- Echoing Green Fellowship, $90,00 annually for 2 years, insurance, and professional development funds for early-stage startups and innovative ideas
- Kickstarter - Raise $50,000 - $100,000 in exchange for free products or Unum tokens

Blockchain Specific Funding

There is also a unique opportunity to build fundraising into Unum itself, through offering Unum investment tokens, a speculative financial asset that allows people to "buy shares" of the Unum blockchain using cryptocurrency. If viable, Unum Investment Tokens can be created, separate from Unum Tokens used to process transitions on the platform. These Investment Tokens will both be offered through a Token Sale and to Partner maker centers as part of a cooperative business model.

Final Reflections

Looking Back at the Thesis Experience

Unum is a manifestation of my real belief that it is critically necessary to investigate alternative economic paradigms to Capitalism, a research topic I would like to explore in much greater detail after graduation. There is a unique opportunity to use emerging technology to radically transform processes that don't work for the majority of people, to reimagine the definitions of success for global systems of economic power and social control. If these technologies are not explored by a diversity of people, they will only be used to support the currently established asymmetries of power that exist across industries and in many ways, are only made worse by digital technology.

Throughout thesis research, this goal motivated me to study a range of topics in a truly transdisciplinary attempt to identify opportunities for intervening at the systems level, for shifting paradigms and worldviews of what is possible for our economic futures. While my early intent was to use a more speculative and artistic approach to illustrate the new collaborative opportunities emerging technology could bring, I quickly realized that technology such as the blockchain protocol is fundamentally difficult to understand for most people. At first I thought this was because it was technically complicated and few understood how it worked. However, after creating early prototypes such as BlockSettlers, an instructional board game and interactive learning experience for designers to technically understand how the blockchain functioned, I quickly realized that the technology isn't what is tripping people up, it is the philosophy.

Through later research, notably the work of Jeremy Rifkin and Douglas Rushkoff, I began to understand the historical and institutional complexities of capitalism and how it evolved throughout the centuries. This opened up my eyes to new frameworks for understanding capitalism as media, as software, which has specific rules and functions that make it function the way it does. Even after studying economics for my undergraduate degree, the revelation that the problem isn't the way the system works, rather it's the underlying assumptions, the constants that are truly at fault. This new perspective helped me to realize that the blockchain protocol is so foreign to people because it fundamentally goes against the programming of our capitalist paradigm. Never in history have complex organizations of individuals been able to coordinate exchanges of assets peer-to-peer without a third party to help manage trust. The blockchain is so hard to understand because it represents the ability to do just this, and ability that is not currently supported by political, social, and economic infrastructures. The potential for this new technology is breathtaking, but it requires people to understand how transformative it could truly be if creative use cases are found for its adoption, rather than a faster way for banks to move around money and do stock trades.

I later became interested in concretely demonstrating the potential for the blockchain to disrupt our economic systems, and after speaking with Audrey Fox, realized that it could present a huge opportunity for making and manufacturing. In retrospect, I wish that this insight had come earlier, so more developed prototypes and tests could implemented for Unum, but I firmly believe that this venture, in practice or in spirit, is a truly unique use-case that resonates with normal people. Everyone loves to make things, and everyone wants credit and maybe even payment for their work. Given the democratizing ability of technology, more and more people want to make and trade things, and more and more people want to buy things from artisans, craftsmen, designers and makers. People are tired of consumer culture, and one way or another they are breaking out of it however they can, looking for more natural, interconnected, and distributed relationships among each other instead of brand-loyalty to anonymous corporations and internet platforms.

The blockchain is a natural fit for distributed manufacturing because it also articulates this philosophy.

It is meant to help people share, access, and get paid for their digital and physical content-creation, unlike current online platforms who extract value by providing the sharing free, but selling user's information. Given today's social and political climate, people understand why the blockchain is important when articulated through the use-case of digital manufacturing because it solves a need they have, and addresses a growing mistrust of third-parties. Banks were bailed out, government has been riddled with accusations of data-manipulation and targeted advertising, and just recently internet service providers were added to the list of online platforms that can extract information from customers usage. Now more than ever, people are ready for the blockchain.

The most important part of the thesis process was having the time and the space to dig deep into a question to understand what problems it truly contained and how technology could provide solutions that went beyond addressing an immediate need. My design philosophy is that we must constantly use technology to question, to imagine new possibilities for how the architecture that supports modern life can work. Learning about the blockchain protocol and distributed manufacturing helped me to move from imagination to the tangible, and really understand not just how the technology works but what it really could mean for our society.

In addition, given my experience helping several people start ventures over the years, Unum presented an amazing opportunity for me to blend my business experience with design and making skills learned through time spent at Parsons MFA Design + Technology to take this research and turn it into a tangible business opportunity, something I have always wanted to do.


IN CASE OF EMERGENCY:
DIAL 911
& Notify Campus
Security 212-229-7001

Conclusion

Conclusion

The Future is Here - Let's Distribute It

While Unum is a business in practice, it is truly an exercise in speculation and curiosity. The project really began with a story about the future, a design fiction exercise where I imagined a future economy that let people earn income from collaborating on digital design projects and their physical manifestations, seeking to address global economic and environmental challenges. But what began as fiction quickly became real as I learned to use a design thinking methodology and systems-level approach to identify the steps it would take make my vision a reality.

Like my story, Unum envisions a future where people are paid for contributing ideas as micro-entrepreneurs, not their time as employees. I believe wholeheartedly in this future and am excited to spend my career as a designer, maker, business-person, and human to make it real. A future where technologies that can help people self-organize in more flexible and organic business relationships are the norm. Where Uber is owned by cab drivers and where Amazon is just a market for artisans' goods. A future where business is shared between real people, not aggregated by abstract corporate entities. And most importantly I believe that the seeds of this future are already here, they are just not yet widely distributed.

As designers, it is our job to spread them far and wide.

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Appendix

Appendix 1

Primary Research Interview Questions for Designers, Makers & Customers

Designers

Introduction

We are studying how we might create a platform that brings customers, designers, and makers together in new collaborative relationships that connect globally-sourced designs with local making and manufacturing. We would like to ask you a few questions to help us learn more about your experience as a designer, what you make, how you make it, and how you sell/promote your work. If possible, we would also like to record your responses via audio so we can speak more naturally now and take some time notes later.

Screening Questions

- Are you a student?
- If yes, what are you studying? (must be design related, industrial, product, tech etc.)
- If no, what would you say your title/job/sector is? (must be design related, industrial, product, tech etc.)
- Have you ever designed products/art/furniture that you would like to sell?
- Do you own a smartphone or computer?
- Have you ever sold your designs/products online or would you be interested in selling your designs/products online?
- Would you say that you have enough time/money to mass-produce or produce a decent amount of your products for sale online (like on Etsy etc.)
- Would you say that you are interested in sustainability, local and new manufacturing and fabrication techniques (like 3d printing, inc, laser) and/or designs and products that support new models for designers and makers to manufacture products together?

Interview Questions

Current Designs & Selling

- What kind of design would you say that you do? (product, industrial, tech, mixed, artist etc.)
- What kinds of materials and design tools do you typically work with? (digital tools like Illustrator, Photoshop, AfterEffects, AutoCAD, physical tools like carpentry tools, pottery, CNC, laser, 3D printing)

- Have you ever sold one of your designs for money?
- If yes, where did you sell it? (Online, retail store, sample-sale, person-to-person, custom-order)
- If online, what platform did you use?
- What was your experience like with that platform? What did you like, what didn't you like?
- Did the platform charge a listing fee or a fee for you to post your product?
- How much money would you say you made from selling your product/products on this platform?
- Did you ever experience times when you couldn't keep up with production, packaging or shipping demands?
- If no, would you like to sell your work?
- What has prevented you from selling your work so far?
- Where do you think you would want to sell your work?
- How many copies of your work would you want to sell (mass-produce it, customize on demand, only a limited run).
- Have you ever traded design-work for products/services/money? (freelance designer, collaborated and got a free product/service traded back etc.)

Selling Experience & Process

- Would you feel comfortable sharing your design files (Illustrator, AutoCad) on an online platform if we could guarantee they were secure and you would be paid each time they were downloaded/used?
- If yes, would you want to use a verified license like creative commons or copyrights to protect your work?
- If yes, would you want something on the physical product that could ensure it was a licensed copy of your work?
- Where would you want this thing to be and what would it look like? (hidden, part of the design, featuring your logo or mark, very plain and small)
- Would you feel comfortable having another person (professional maker, fabricator, manufacturer) produce an actual physical product from your design files?
- How comfortable do you feel about this?
- What would make you feel more or less comfortable?
- Would you be willing to allow your product/design to be made in a range of customization options?
- Size? (within range or custom to order by making center)
- Materials?
- Assembly Options?
- How many options for each?
- Would you be willing to write or draw instructions that allowed a maker to cut-out your designs (CNC, Laser), reproduce your design (3D Printing)?
- What do you think would be better, written or drawn?
- Would you be willing to write or draw instructions that allowed a customer to assemble your design from the pieces the maker created?
- What do you think would be better, written or diagrams/drawings?

Platform

- If you were to upload your designs to a platform for the purposes above, what type of files do you think you would be uploading? (illustrator, auto cad, physical 3d mock-ups)
- What features would you want on the platform/website to help you upload your files, describe your product, include photos, write instructions etc?
- Would you be comfortable with customers reviewing or rating your product if purchased?
- How nice the design was.
- How easy it was to assemble.
- Reviews of the material and pictures of it in people's homes.
- Would you be comfortable doing short interviews for a blog or other community on the platform to talk about your work?
- Would you be comfortable putting up your biography on the site?

Compensation & Pricing

- What is your hourly rate for freelance design work, if you have one?
- How many hours would you say you put into designing a particular item/product (range is okay)
- How many hours spent on research and development?
- How many hours spent on design files?
- How many hours spent on prototyping?
- How many hours refining designs until you have a finished product?
- How much money do you think you should receive for someone just purchasing one copy of your design file, if you didn't have to make the product, ship it, nor assemble it yourself for them?
- How many copies of your work would you want to sell?
- How would you feel about the price of purchasing a copy of your design changing based on how
- Popular the design is as rated by users
- # Total Design Copies Purchased
- If a user purchased a copy of your design, had it made, grew tired of it, and wanted to recycle the product with the maker and sell the license to the copy, would you feel comfortable with them doing that?
- If a user's physical build of your design broke, would you feel comfortable with them getting it reproduced by the maker without paying you an additional license fee?

Miscellaneous

- What types of design products do you think would be best for a platform like this?
- What platform features would really make you want to use a site like this?
- Any other thoughts or advice?

Makers

Introduction

We are studying how we might create a platform that brings customers, designers, and makers together in new collaborative relationships that connect globally-sourced designs with local making and manufacturing. We would like to ask you a few questions to help us learn more about your experience as a maker/makerspace, how you make money, what types of services you offer, and what you might be interested in offering in the future. If possible, we would also like to record your responses via audio so we can speak more naturally now and take some time notes later.

Screening Questions

- Do you work for a maker center, furniture/product fabrication shop, fab shop or related organization?
- Would you be open to producing items designed by other people (designers that could be located anywhere) if you had sufficient standards and instructions?
- Would you be open to using a digital platform to receive, queue, manage and produce these types of products if you are fairly compensated for materials and labor?
- Would you be open to keeping a standardized stock of materials on site that could be used to produce these products?
- Would you be open to using a proprietary platform that helps embed the products with physical tags that can track digital ownership?
- Do you, or would you be open to delivering the unassembled or assembled products?
- Do you, or would you be open to assembling the items for a fee?
- Do you have a computer/smart-phone at your location?
- Are you comfortable, or does your organization have staff comfortable with using only platforms and interfaces?

Interview Questions

Current Making Experience

- What types of things do you and/or your shop make?
- Products, Furniture, Artwork
- What types of digital fabrication tools do you have at your shop? (Laser, CNC, 3D Printing, PCB)
- How does your shop typically make money? (local manufacturing, education, membership for startups and entrepreneurs?
- Do you locally manufacture products/goods/designs for private customers?
- If yes, what types of customers (commercial, individual, educational)?
- If yes, where do these customers find you and learn about your services?
- If yes, what proportion of your total business revenue would you say this activity brings in? (all of it, half, only a little?)
- If yes, how many of these products do you typically produce at one time? (several, made to order) etc.
- If yes, what do you like and what don't you like about work like this?
- IF NO... Would you be interested in doing work of this type?
- Is work of this type conducive to your current business model?

- Do you sell products on-site or allow customers to pick up products from your shop?
- Do you deliver products locally, regionally, nationally, internationally?
- Do you assemble products on-site? If yes, do you charge extra for this?

Compensation & Pricing

- How much do you typically pay workers at your business? (on average)
- Do you have a collaborative, cooperative business structure or allow companies and individuals to invest in your space in some way?
- What proportion your total costs go to materials?
- What proportion of your total costs go to capital (fixing machines, buying new machines, electricity, etc.?
- What would you say the biggest cost is to your business overall?
- Were you opened with any sort of grant or community funding? Do you receive any grants, public or community funding?

Platform & Making Process

- Would you be interested in participating in a platform that helped connect you with designers ideas which you could produce locally if fairly compensated for cost, labor, and overhead?
- How much profit would you want to make on items sold this way?
- What types of products do you think would be a good fit for a platform such as this?
- Would you be willing to use a standard set of materials designated by the platform to make different custom combinations? (some made from wood, some from acrylic etc.)
- Would you be willing to make the products to order if easily doable from the designers design file?
- Would you feel comfortable signing a contract or other legal agreement saying that you would not re-copy, save, or reproduce a designer's file unless it came through the platform?
- Would you be interested/willing to do video tours of your maker center, meet the maker blog posts/articles and other promotional activities?
- What aspects of the platform would help you manage workload, orders, demand and other considerations if orders were being routed to your center from this online source?

Misc

- What types of design products do you think would be best for a platform like this?
- What platform features would really make you want to use a site like this? As a maker, and as a customer.
- Any other thoughts or advice?

Customers

Introduction

- We are studying how we might create a platform that brings customers, designers, and makers together in new collaborative relationships that connect globally-sourced designs with local making and manufacturing.
- We would like to ask you a few questions to help us learn more about your experience purchasing home products online including furniture, shelves, homegoods (lamps, fixtures, pen-holders), and art/design pieces.
- If possible, we would also like to record your responses via audio so we can speak more naturally now and take some time notes later.

Screening Questions

- How old are you? (can give a range)
- Do you typically have enough extra money to buy your own furniture, home-goods and design/art products (pictures, statues, electronics etc.)
- Have you ever purchased your own furniture (couch, chair, bed, shelves)?
- Do you own a smartphone or computer?
- Have you ever used the internet to buy furniture, designed home products or art products?
- Have you ever used the internet to buy furniture, designed home products or art products directly from artisans and designers (Etsy. Bought directly from a designer etc.)?
- If yes, why did you choose to buy directly from an artisan vs. a retail store?
- If yes, what helped you feel connected to this particular designer or artisan, how did you hear about them and their work? How much information did you know about them? Have you bought other pieces they created?
- Have you ever sold/trade/shared items on an e-commerce site (like craigslist, facebook marketplace)?
- How good would you say your English is?
- Do you feel confident browsing/posting on shopping/e-commerce sites in English?

Interview Questions

Current Purchasing Preferences for Products/Furniture

- Would you say that you frequently purchase furniture, products, or art from online retailers?
- What was the last piece of furniture, product or art you bought online?
- Did you assemble it yourself, did it come assembled, or did you pay extra to have it assembled at your home?
- Where do you typically purchase your furniture from (online, store like IKEA etc, second-hand)?
- Where do you typically purchase your home-goods from (planter, pen-holder, desk accessories)?
- Have you ever purchased furniture, products or art from an individual designer - like on Etsy, Facebook Marketplace, small-design studio site etc?
- Did you think it cost too much, was reasonably priced, or was underpriced?
- What did you think of the quality of the finished product? Was it what you expected?
- What kinds of products, furniture, or art would you like to buy online in the future and which would you only want to purchase from a physical retail location?

Customization, Collaboration, Making & DIY

- Do you participate in online communities, sharing circles, blogs, or collaborative projects where you follow news and comment/review stories or items? (Medium, Instagram, Facebook)
- What types of platforms do you participate on and why do you like participating on them?
- Do you ever follow a particular designer, company or brand you don't know personally? Why?
- Have you ever made your own furniture or home-goods using instructions from a DIY book, site, or reference?
- If yes, what did you build and why did you want to make it yourself?
- What online or physical reference did you use to make it? (Instructables, Youtube, DIY website)
- Would you be interested in assembling your own products if it saved you money?

- Would you be interested in purchasing a design pattern (idea for a product) and then being able to customize aspects of it like the material, size etc.?
- If yes, what would you want to customize about it? (use example to help explain options - fixtures, materials, size within set framework, fully custom sizing)
- Would you be interested in purchasing a product where the digital pattern or idea of the product comes from a designer anywhere in the world, but the product itself is fabricated/cut-out at a local manufacturer or making center?
- How much money, overall would you want to spend on the following items if purchased online and shipped to you unassembled.: Couch, Chair, Shelf/Shelving Unit, Pen-Holder, Statue or Sculpture, Wall-Art, Lighting Fixture
- Would you be interested in supporting up and coming or student designers if the products were unique and well-made?

Blockchain & Payment System

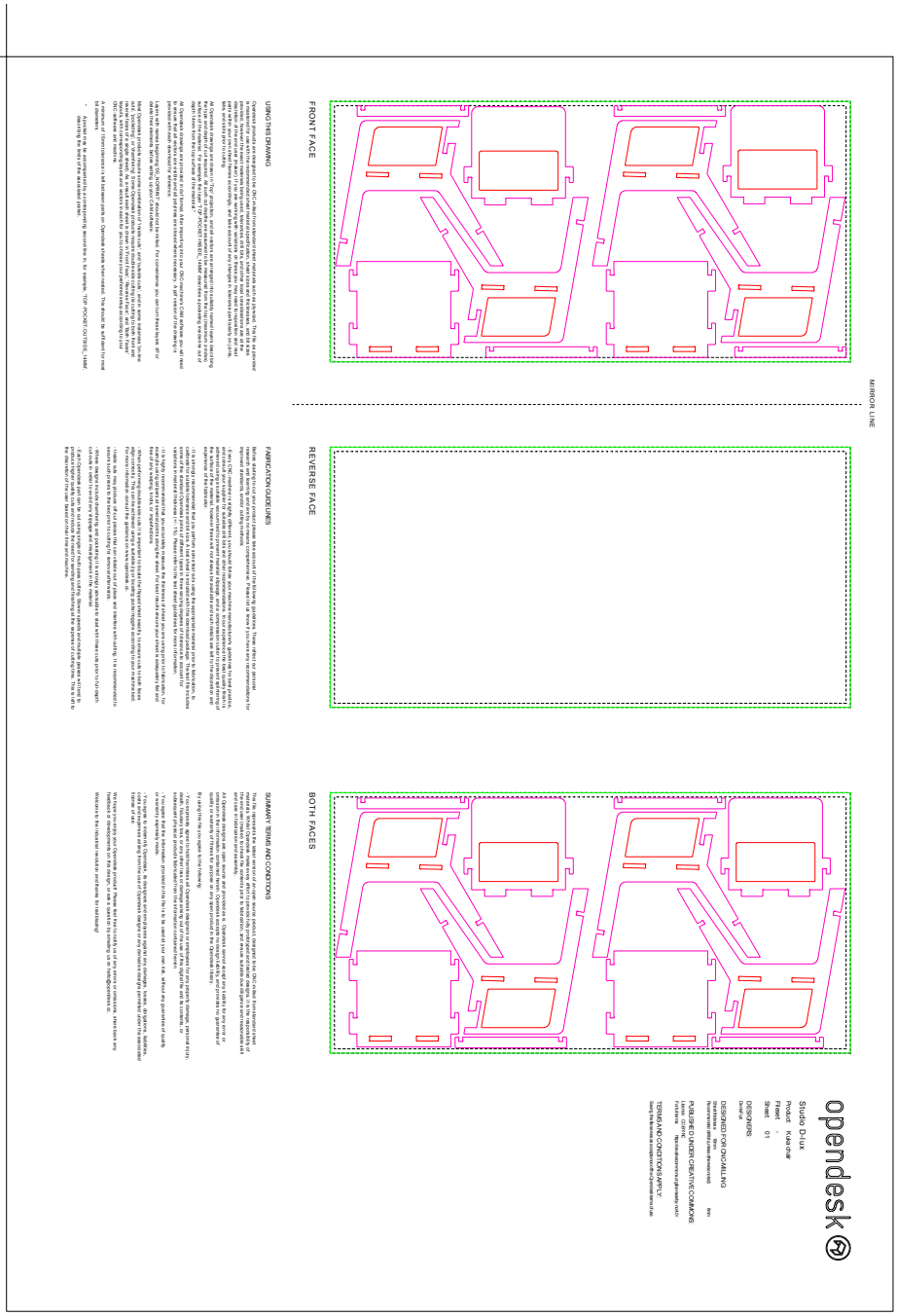
- Would you be interested in knowing that the product you have is a licensed physical copy of a digital idea? (rather that the designer posted the idea and and final physical thing could be checked for authenticity)
- Have you ever heard of the blockchain protocol or Bitcoin?
- If yes, give a brief summary of how you understand what it does.
- If yes, have you ever purchased a blockchain-based currency (Bitcoin, ethereal) or tried to use a blockchain application (open bazaar, Ethereum etc.)
- Would you feel comfortable purchasing tokens or platform-specific currency that could only be spent on the platform using your own currency?
- If yes, would you want the currency to be pegged to a specific exchange rate (1 token always equals 1 dollar) or for it to shift with supply and popularity of using the tokens (like in some online games).
- If yes, would you want to be able to cash your currency back out of the platform if you had extra leftover that you didn't need/want anymore?
- Are you familiar with creative commons licenses and open-source hardware, software, or designs (noun-project e.g.)?
- Have you ever noticed that something you download for free or saw used somewhere had a creative commons license associated with it?

Miscellaneous

- Would you also be interested in designing furniture, home-products or art for a platform like we are describing?
- Would you be interested in actually going to the manufacturing or maker center and learning how to use the tools that are creating your products if it was nearby?
- Would you be interested in voting/reviewing/describing the products you purchased through a platform like this if it offered monetary incentives (in terms of extra tokens, or changing the price of designs based on their popularity?)
- Would you take a video of yourself assembling the item step-by-step or some similar documentation if it offered financial incentives (in terms of extra tokens or special materials, editions etc.?)
- Overall, does purchasing things this way (buy a verified license of one copy of the global idea, make it locally) appeal to you?

Appendix 2

KUKA Design Chair Fabrication File from OpenDesk



Appendix 3

White Paper

D'MAKE | HOW THE BLOCKCHAIN PROTOCOL CAN SUPPORT DISTRIBUTED MANUFACTURING

Summary

The Maker Movement is already redefining labor and capital relationships for the 21st century. Fueled by the proliferation of affordable digital design and fabrication tools, this movement is democratizing production and decentralizing manufacturing, giving many the ability to craft and sell their own products. Consequently, new, distributed forms of manufacturing are emerging that benefit local and regional economies. However, while more and more makers are becoming micro-factories there is still no viable framework or protocol to help them coordinate with designers and customers peer-to-peer. Instead they must use online intermediaries to exchange assets of value - money and intellectual property (IP) like designs or manufacturing information. This reliance on third-parties negates many of the economic and environmental benefits distributed manufacturing networks can bring. For this reason, while many have tried to make distributed manufacturing a competitive alternative to the way things are produced today, no organization has yet succeeded. There is both an urgent need and tremendous opportunity for new solutions and ventures that can address these critical limitations and find a way to create trusted collaborations directly between people, without the need for third parties.

The emerging blockchain protocol can solve this issue, building the necessary internal and external value networks for an entirely new infrastructure for provenance and supply chain management that is transparent, ethically minded, and community-driven.[1] The blockchain protocol has the potential to create a distributed value-network to support equally distributed manufacturing networks that are founded on trusted peer-to-peer contractual relationships between designers, makers, and customers over digital networks.

A proof of concept platform and business was developed and prototyped to explore if and how the blockchain could work in this sector. Unum is a distributed manufacturing platform that uses blockchain technology to connect makers, designers, and customers in trusted peer-to-peer relationships, without intermediaries. Unum envisions a future where products of all types can be created through blockchain based distributed manufacturing networks, and takes the first steps towards this future by using blockchain smart contracts to coordinate the unique intellectual property and compensation needs of designers and makers.

Background | Making Distributed Manufacturing Viable for the Future

Just like the internet decentralized information, manufacturing technology innovations have decentralized production and similarly driven the marginal cost for making physical things closer and closer to zero. These tools have also removed capital-based barriers to entry for individuals and small businesses, laying the foundation for a more distributed manufacturing industry where several different sized companies can meet consumer demand as well or better than the current top-down centralized system. Many business leaders and economists already see this shift occurring and believe today's resulting Maker Movement represents the beginning of a larger third industrial revolution signalling the end of the corporate capitalist era. They predict that the rise of distributed manufacturing in conjunction with new collaborative and networked relationships directly between people all over the world will replace traditional business models by the end of this century.

But the reality is that the infrastructure needed for this 'revolution' to disrupt traditional manufacturing relationships is not yet in place. While the technology

1 ConsenSys, "The Supply Circle: How Blockchain Technology Disintermediates the Supply Chain," ConsenSys Media, March 09, 2016, , accessed April 01, 2017.

exists to democratize the design and production of goods, no viable solution has yet been found to manage trusted business relationships between the key stakeholders of manufacturing in a truly distributed fashion. Until designers, makers, and customers can connect with one another peer-to-peer to exchange the necessary assets of value inherent in these relationships, distributed manufacturing can never become a revolutionary alternative nor a viable competitor in today's economy.

Two different approaches are currently being taken to address these critical issues.

Online Manufacturing Platforms

Today, designers can either send or list their digital designs on online manufacturing platforms like Shapeways and Thingiverse. These companies will either produce a run of products and ship them to the designer to sell on their own, or price and list the item on their in-platform marketplace, producing it on-demand from a preset range of customization options every time a customer buys a copy. The designer can set a markup fee to make a profit if so desired. While this is great for designers, the products are shipped from wherever the platform's factory happens to be located, negating any economic or sustainability benefits that come from centering production around a consumer's location.

Open-Making Platforms

Others try to support distributed manufacturing by adopting models from the open-source software movement to create 'open-making' networks. Online platforms such as OpenDesk allow designers to list design files that anyone can download and fabricate non-commercially through creative commons licensing. If large quantities are needed or if users don't have the necessary digital fabrication tools, OpenDesk can route their request through a network of partner makerspaces who will produce and deliver the items. Here, OpenDesk coordinates all of the compensation, paying out maker's manufacturing costs, designer's design fees, and other delivery and assembly costs. Designers can choose whether or not to make their designs free or paid to download and if paid, users will pay a fixed-price set by the designer and the OpenDesk platform fee.

While this model does solve for centering production around consumers (depending on how close they are to a partner makerspace), it has two critical flaws.

Managing Intellectual Property for Physical Products

While designers can choose to make designs 'paid', once their file is downloaded, they no longer have control over their intellectual property. Users can copy and distribute their file and there is no realistic way to ensure that the non-commercial license granted upon download will not be violated once the physical object is fabricated.

Supporting On-Demand Production

While it would seem that digital designs can be automatically fabricated if the right machine is used, this is hardly the case. Variations in materials, machine settings, and production processes make it very difficult to create low quantities of products on demand, since significant setup and testing is needed before fabrication. Makers rightly consider all this pre-work their own intellectual property, a manufacturing kit that is just as important as the actual design and are not incentivized to share it with other makers in the network, allowing for on-demand production to be much more easily accomplished. Open-making platforms dont' take these forms of IP into account nor offer a viable way for partner makers to share and be compensated for their work.

In order to solve for these issues, there must be a way to coordinate trust directly between designers, makers, and customers when creating physical products that originate in digital designs. What is needed is an equally distributed value network that can connect these parties peer-to-peer in order to create, manage, exchange, and be compensated for their contributions to the production process. Until this infrastructure is created, distributed manufacturing will remain an interesting social experiment and niche production method instead of a revolutionary new way to purchase sustainable, locally produced consumer products on-demand.

Blockchain, the Trust Protocol

Blockchain technology represents a unique opportunity to solve for these issues, building the necessary internal and external value networks to support distributed and on-demand manufacturing through a network of maker spaces. The blockchain protocol has the potential to create a distributed value-network to support equally distributed manufacturing networks founded on trusted peer-to-peer contractual

relationships between designers, makers, and customers over digital networks.

What is a blockchain?

The blockchain protocol is a software mechanism that "...provides a distributed system of trusted assets and transactions without the need for a central trust authority." Best known as the term for the database underlying the digital cryptocurrency Bitcoin, the blockchain broadly refers to any distributed electronic ledger that uses cryptographic software algorithms to reliably and anonymously record transactions. At its core, the blockchain is a self-sustaining, peer-to-peer database that can manage and record transactions without a clearinghouse to prevent the double spending problem inherent in digital information and assets.

There has never before been a way to facilitate trusted transactions directly between two or more parties that is authenticated by mass-collaboration and powered by collective-self interest. Instead of an Internet of Information, the blockchain can be thought of as an Internet of Value that can be programmed to record virtually any valuable asset: financial records, provenance of items, votes, money, intellectual property, certifications and anything else that can be translated to code. Blockchains also allow for the creation of smart contracts, pieces of software that can automatically implement terms of multiparty agreements. "Smart contracts are executed by a computer network that uses consensus protocols to agree upon the sequence of actions resulting from the contract's code. The result is a method by which parties can agree upon terms and trust that they will be executed automatically with reduced risk of error or manipulation."

How the Blockchain Supports Distributed Manufacturing

Given that the blockchain enables the tracking of all types of transactions, it can create a digital thread that represents the lifecycle of a product from its initial design file and material origins to the purchase and ownership of the finished product. Since these transactions are all tracked digitally, designers and makers who are geographically separate from one another can collaborate in a trusted fashion to create products. Blockchain smart contracts can automatically compensate each party for their contributions to the process. The blockchain can even support shared and remixed designs, allowing other designers to modify the original file and submit their version, compensating every designer along the chain each time the file is produced. In this way, the blockchain remains true to the ethos of open-making by creating middle-ground between truly open and proprietary designs where anyone can collaborate on products and be paid for their unique contribution of intellectual property. Blockchain's immutability, auditability, and transparency allow product's lifecycle to be securely recorded and shared making the manufacturing supply chain completely transparent for customers. Finally, consumers can know exactly where their products came from, making them more informed of their impact as economic actors.

Unum | The Blockchain for the Maker Movement

A proof of concept blockchain d'app (distributed application) and online platform were created and prototyped in order to test how this model might work today. Unum creates the first viable electronic infrastructure to coordinate trusted peer-to-peer business relationships between designers and makers while giving customers complete transparency into their product's origin and manufacturing lifecycle. By leveraging the emerging blockchain protocol, Unum facilitates trust by encoding each party's terms and conditions into smart contracts that create and manage all transactions along a unique digital manufacturing thread for every physical product instance fabricated from a digital design. This thread is immutably tied to the finished product through Unum's proprietary NFC-based seals, which are embedded and activated by makers during production, allowing customers to own a verified physical copy of a digital idea, forever.

Unum provides several unique benefits to designers, makers and customers with the blockchain providing a unique value-add for each audience. Through helping these stakeholders, Unum also benefits communities.

Conclusion

In conclusion, the blockchain protocol can be leveraged to support the future of distributed manufacturing in three important ways. First, blockchain smart contracts allow for the secure and seamless coordination of compensation and design/manufacturing information, empowering designers and makers of all types to collaborate peer-to-peer to produce and sell products. The blockchain also raises important questions that will be integral to the future of distributed manufacturing, opening up a new middle-ground for coordinating intellectual property and licensing in a future where more and more individuals will be able to produce and sell their own products and IP becomes

of paramount importance. Finally, it allows global ideas to be fabricated locally and on-demand, creating new networks of value for local and regional economies and providing huge environmental benefits. The blockchain protocol truly provides a unique opportunity to build the future of distributed manufacturing on equally distributed terms. By extending the decentralization of the Internet Revolution to our economy, the blockchain can empower people to have more meaningful and sustainable relationships with each other, their products, and their world.

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Appendix 4

Business Plan

Executive Summary

Introduction

The Maker Movement is redefining labor and capital relationships for the 21st century. Fueled by the proliferation of affordable digital design and fabrication tools, this movement is democratizing production and decentralizing manufacturing, giving almost anyone with access to a computer the ability to craft and sell their own products. However, no viable system yet exists to coordinate manufacturing relationships in a truly distributed network.

Unum harnesses the blockchain protocol to do just this, bringing designers and makers together in trusted collaborations and connecting global ideas to local on-demand production that is centered around customers. By encoding each party's terms and conditions into smart contracts, all transactions can be managed along a unique digital manufacturing thread for every physical product fabricated from a digital design. This thread is immutably tied to the finished product through Unum's proprietary seals, embedded and activated by makers during fabrication, allowing customers to own a verified physical copy of a digital idea, forever.

Unum envisions a future where home-goods, furniture, art and electronics are created through distributed manufacturing channels, supporting more sustainable, transparent, and community-driven production.

Company & Management

Unum is currently located in New York City, a location with access to both designers and potential customers, as well as a rich technology ecosystem that can support platform development and testing for blockchain applications. Makers will initially be sourced from the wider NYC metropolitan region including upstate New York, Long Island and parts of New Jersey and Connecticut.

Founders Dana Martens and Audrey Fox both bring distinct and complementary skillsets to the business including deep experience in design, technology, and business practices. Dana Martens is an experienced designer and project manager with a background in social innovation, economic development, and startup coaching. She actively exploring how the blockchain can enable new economic relationships, support cooperative business models, and create a true sharing economy. Dana is responsible for operations, business management, fundraising, and recruiting blockchain partners and maker clients. Audrey Fox is a talented brand manager and UX designer with experience in digital and traditional fabrication techniques and sustainable product and system design. She is actively exploring how digital fabrication can be harnessed to disrupt traditional manufacturing models and global supply chains. Audrey is responsible for graphic and web design, branding, product specifications, and recruiting design partners.

We will recruit a full-time maker teammate experienced in a range of digital fabrication tools and have already approached several students at Parsons School of Design who expressed interest in participating after graduation.

Market Opportunities

Unum leverages a unique market opportunity that capitalizes on the convergence of several emerging trends in consumer goods and manufacturing, enabled by rapidly accelerating technological innovations in digital fabrication and the emerging blockchain protocol. Combined, these trends are predicted to radically disrupt and redefine economic and business relationships in the next five years.

Given these trends, the company is well-positioned to raise funds and gain market share. Unum leverages a strong, yet time-sensitive, investor excitement in blockchain ventures to innovate around critical issues

in distributed manufacturing. In addition, the growing demand for sustainable and responsibly manufactured products from Unum's target market creates a high potential for sales. Paired with relatively low initial investment costs (since we will not need to buy any physical equipment), this sales potential can quickly be turned into profit, allowing Unum to quickly become financially sustainable as it builds its reach and impact.

Competitive Advantages

Distributed manufacturing platforms are a direct yet not well established competitor. Our two primary competitive advantages are better management and coordination of intellectual property between stakeholders and the superior transparency, security, and auditability the blockchain protocol enables when tracking a product's provenance and lifecycle.

We will also build Unum into a strong online community and social network to better engage customers by allowing them to learn more about designer and maker partners and provide feedback and pictures of their customized products.

Financial Projections

- Unum expects to break-even in the middle of its second year, based on projections for technology testing and deployment and curation of initial products.
- Unum expects to earn a modest profit by the middle of year two based on projected tests times and ales.
- Initial growth will be slow as the technology is tested and refined through the live-beta launch of the blockchain d'app and web store.
- Initial operating costs will be low as Unum will not own any significant machinery or capital that must be maintained and operated.
- We plan to raise $250,000 in non-equity investment fundraising to allow three team members to work full-time on the project and hire a blockchain developer.

Overview & Objectives

History & Vision

Twenty years ago, the Internet Revolution decentralized information, radically reducing the cost for searching, collaborating, and exchanging info between individuals and lowering the barrier to entry for entrepreneurs and small businesses to distribute and manufacture products and services, disrupting entire industries. Today, the Maker Movement represents a similar opportunity. By leveraging the increasingly available and ever-cheaper digital design and fabrication tools (3D printing, laser-cutting, CNC routing, microcontrollers, and even machine knitting and textiles) this movement represents an unparalleled opportunity to disrupt traditional, centralized and globally dispersed manufacturing, addressing critical economic and environmental issues.

While many companies have began to explore the opportunity to distribute manufacturing, all rely on outdated centralized platforms to secure and validate the transfer of digital assets (money, intellectual property) between designers, makers, and customers. These rigid platforms are unable to account for the flexible and nuanced relationships between designers and makers, failing to properly manage intellectual property and compensation.

There is both an urgent need and tremendous opportunity in creating solutions to address these limitations, creating trusted collaborations directly between stakeholders.

Unum is a decentralized application (d'app) that coordinates distributed manufacturing relationships between designers, makers, and customers using the blockchain protocol. Paired with online marketplaces, this platform can bring designers and makers together in trusted collaborations, connecting global ideas to local on-demand production that is centered around customers. Unum envisions a future where furniture, clothing, art, and electronics can be produced through distributed channels, supporting more sustainable, transparent, and community-driven production.

Our first goal is to build and test the Unum platform with a web store that sells CNC and laser-cut furniture and organizational units designed by student designers and fabricated by partner makers in the New York metropolitan area. We will scale our business model in two ways:

- Recruiting additional design partners and widening the maker network throughout New York state.
- Creating a licensing program that allows other web platforms focused on digitally fabricated products (electronics, fashion, art etc.) to use the Unum d'app to connect with maker partners who can meet their needs.

Objectives

- Build and test the Unum blockchain distributed application (d'app) with five maker partners in the New York City metropolitan area by the second quarter of 2018
- Launch the Unum webstore with three design partners working in CNC and laser-cut furniture and organizational units by the third quarter of 2018
- Raise $250,000 in non-equity investment funding (grants, community-fundraising, blockchain investment strategies)
- Break-even and achieve sustainable operating revenue by the first quarter of 2019

Keys to Success

- Create a secure, transparent, and easily auditable blockchain d'app that meets the intellectual property and compensation needs of both designers and makers
- Ensure the Unum D'app has an intuitive user interface understandable by designers and makers with an average level of technical literacy
- Manage the provenance and lifecycle of all physically produced product instances, allowing access to the right information for the right stakeholders
- Provide a simple, intuitive user-experience for customers through the Unum web store
- Articulate and explain the benefits of the blockchain protocol and distributed manufacturing to customers clearly and concisely
- Curate unique, collaborative, and high-quality designs that meet the lifestyle needs and budget of millennials living in urban areas

Products & Services

Product Description

Unum is the first viable electronic infrastructure to coordinate trusted peer-to-peer business relationships between designers and makers while giving customers complete transparency into their product's origin and manufacturing lifecycle. Unum leverages the emerging blockchain protocol to facilitate this trust by encoding each party's terms and conditions into smart contracts that create and manage all transactions along a unique digital manufacturing thread for every physical product instance fabricated from a digital design. This thread is immutably tied to the finished product through Unum's proprietary NFC-based seals, which are embedded and activated by makers during production, allowing customers to own a verified physical copy of a digital idea, forever.

The Unum web store will feature a line of unique products that reflect the needs and budget of older Millennials and younger Gen-Xers who can afford to buy new furniture and home goods, but not products from designer brands and design studios, or custom-designed pieces. Each Unum product reflects a unique collaboration between customer, designer, and maker, allowing for custom materials and builds that make every product one-of-kind. Using the Unum seal, every customer can both access their products digital production narrative and own a licensed physical copy of their design forever. Physical pieces can even be recycled by certain maker partners and re-created by customers according to their needs, allowing them to re-customize products and only pay the fabrication fee for future versions.

Together, the Unum d'app and the Unum web store provide an end to end solution, both enabling makers to produce licensed physical copies of designers ideas for local customers and helping customers discover these products and access their manufacturing lifecycle in a seamless and well-curated online marketplace. Each product represents a unique collaboration between Products will be price

Competition

Unum has several clear advantages over its primary competitors in distributed manufacturing:

- Many rely on a centralized platform and factory for fabrication, failing to truly colocate production

around customers, and not meeting customers demand for responsibly manufactured products

- None currently use the blockchain protocol to manage transactions between stakeholders, lacking the transparency, auditability, and security of a decentralized application (d'app).
- There are only a handful of truly distributed manufacturing platforms, and most exist abroad and/or serve commercial versus retail clients

Future Products

Taken to scale, the Unum d'app can allow any online marketplace to connect with a distributed manufacturing networking of maker partners. As long as a product can be digitally fabricated - meaning that it can be produced using a digital fabrication tool that replicates a copy of a digital design - Unum has the potential to support it. Products are only limited to those that can easily be digitally fabricated on demand (more and more daily), and by the tools and space available to maker partners. Given the rapidly increasing availability and decreasing cost of digital fabrication tools, the additional revenue generated by participating in the Unum network can allow makers to invest in a wider range of machines and materials, generating a virtuous cycle of new product opportunities across several types of manufacturing.

Market Opportunities

Market Summary

Manufacturing technology innovations have decentralized production and similarly driven the marginal cost for making things closer and closer to zero, removing capital-based barriers to entry for individuals and small businesses, and laying the foundation for a more distributed manufacturing industry where several different sized companies can meet consumer demand as well or better than the current top-down centralized system.

However, the infrastructure needed to grow this new opportunity and disrupt traditional manufacturing and retail markets is not yet in place. While the technology exists to democratize the design and production of goods, no viable solution has yet been found to manage trusted business relationships between the key stakeholders of manufacturing in a truly distributed fashion. Two solutions currently exist that try to address this problem.

Some players in the distributed manufacturing market allow designers to send or list their digital designs on platforms (Shapeways, Thinigiverse). These companies will either produce a run of products and ship them to the designer to sell on their own, or price and list the item on their in-platform marketplace and produce it on-demand from a preset range of customization options.While this is great for designers, the products are shipped from wherever the platform's factory happens to be located, negating any economic or sustainability benefits that come from centering production around a consumer's location.

Other ventures are trying to address the idea of locating production around customers by adopting models from the open-source software movement to create 'open-making' networks. In this solution, online platforms such as OpenDesk allow designers to list design files on their website that anyone can download and fabricate non-commercially through creative commons licensing. If customers do not have the necessary fabrication tools to produce the designs themselves or if they require a large number of items that exceeds their production capacity, the platform will connect them with the closest available partner makerspace to fabricate the products for a fee. This is problematic because listing the design openly on the platform means that designers have no way of securing their intellectual property and anyone could download, copy and distribute their file. Our research has also shown that the digital design files listed on the site are not ready for on-demand production. Due to differences in materials, fabrication equipment, and production processes, there is a large amount of prework that must go into testing and building the product that makers are not compensated for. This isn't as big of an issue when creating large-runs of products, but it makes on-demand production unprofitable if only making one copy of a design. Makers consider the adjustments and production processes drafted during the prototyping period as their own intellectual property, or a manufacturing kit that is just as important as the actual design file. These types of platforms don't take this time into account and have no viable way to allow makers to share and be compensated for this sort of work.

Market Trends

Unum provides a unique market opportunity that capitalizes on the convergence of several trends in the consumer goods, manufacturing, and technology sectors. Unum's target customers, millennials, are now the largest consumer group in America, representing a huge market opportunity. Given that Millennials are adept at using technology, trusting of online stores, and more comfortable purchasing products with digital devices than older generations, online marketplaces are rapidly gaining market share in industries such as furniture, clothing, and electronics.

At the same time, emerging digital fabrication tools are disrupting manufacturing processes that rely on economies of scale driven by centralized factories. It is predicted that more and more goods will be produced at or near their point of use in the future. Research also suggests the democratization of production that digital design and fabrication tools bring will decrease demand for physical products and increase the profitability of licensing the digital blueprint of products, blurring the line between manufacturer and customer in the future.

Market Growth

Online peer-to-peer marketplaces are growing in popularity. Platforms that connect makers directly to customers (Etsy, Amazon Marketplace) and those that share, sell, and fabricate customers and designers digital blueprints (Shapeway, Thingiverse) are both fueled by a rapidly expanding maker movement with over 135 million adult makers in the United States alone, or over 57% of the 18+ population. This movement is laying the foundation for new products and processes that can help revitalize American manufacturing and offer strong growth opportunities.

Blockchain ventures are also becoming more and more viable as the technology matures, with very strong investment and growth potential. This technology is just beginning to create tremendous opportunities for extreme social, economic, and technological disruption. Already, Gartner predicts a blockchain business will be worth $10 billion by 2022 and it is forecasted that new business models founded on smart contracts and blockchain efficiencies will emerge by 2020. In addition, over $1 billion of venture capital has already been invested in the blockchain ecosystem and the rate is doubling annually, with the next 12-18 months (as of June 2016) predicted to be extremely important for new venture creation.

Market Needs

In order to address the unsolved issues in the distributed manufacturing market, there must be a way to coordinate trust directly between designers, makers, and customers when creating physical products that originate in digital designs. What is needed is an equally distributed value network that can connect these parties peer-to-peer in order to create, manage, exchange, and be compensated for their contributions to the production process.

The blockchain protocol can help to meet this need by providing an immediate and low-cost assurance of trust. This can unleash unimaginable and disruptive innovation by allowing any supplier, designer, or manufacturer to find one another and begin a collaborative relationship.

By offering a cheap shared resource that has the potential to distribute making and create a true sharing economy, d'apps built on the blockchain can create enhanced transparency, greater scalability, better security, and increased innovation over traditional manufacturing supply chains. The blockchains unique ability to manage identity and reputation, payments and financial tools, and smart contract supported governance will pave the way for supply circles (versus supply chains) that are made up of prosumers who are incentivized and rewarded to behave ethically and sustainability.

In addition, consumers increasingly demand responsibly manufactured products. They both want to purchase sustainably produced goods, but can't find them, and expect companies to address social and environmental issues. Research has shown that 75% (and growing) of Millennials are actually willing to pay more money for sustainably produced goods. They want small, multifunctional, and affordable furniture that fits into their fast-paced and ever-changing urban lifestyles, yet seek out unique designs that show off their individuality.

Sales & Marketing

Target Markets

Unum serves three target markets, providing a service to connect them together in a distributed fashion.

Customers

Target customers are NYC residents of any gender or ethnicity who make between $40,000 and $100,000 annually, rather they have a high enough income for the area to afford new furniture and home goods, but not enough money to access products from designer brands and specialized design studios such as Design Within Reach. For this reason, Unum is primarily focusing on older Millennials and younger Gen-Xers aged roughly between 25 and 40. Our research has shown that people in this age group are community and civic minded, tech-savvy, and prioritize authentic and responsibly-manufactured products. Initially, designs will be curated on the Unum web store to meet the purchasing behavior and paint points of this target segment, who typically live in small apartments and move often as they become established in their careers. Meeting the needs of these specific customers as well as the limitations of digitally fabricated products has informed our choice of design aesthetics, product features, and material choices for early implementation efforts as outlined above. This target segment will be the focus of initial public beta tests of the Unum platform and the model will be adjusted accordingly as new insights are gained. All new customers will be interviewed about the selection and quality of designs available and what they would like to see more of.

Designers

Unum serves upcoming designers who are creating affordable and parametric designs for digital fabrication and are not exclusively attached to design studios or retail factories. The Unum blockchain d'app can eventually support any design that can be fabricated through a combination of CNC routers, laser-cutters, and 3D printers, machine-knitting etc. However, due to initial research insights and testing, the first focus will be placed on recruiting design partners that are working on CNC furniture and home organization units that have a low surface to edge ratio, meaning that they require little finishing. Unum also prioritizes parametric designs, made from sustainable and recyclable materials, that have few fixtures (screws, bolts etc.) allowing finished products to be flat-packed for transportation, and easily assembled and disassembled by customers, supporting modern urban lifestyles that find people moving frequently.

Makers

Unum can serve many types of makers, micro-manufacturers, fabrication labs, and makerspaces etc., as long as they own enough machines - or space and budget for new machines - to handle increased production demands from joining the Unum platform and are open to adopting their existing business model to include distributed manufacturing activities. One early research insight was that there are big differences in the manufacturing capability and organizational mindsets of different types of maker spaces such as hackerspaces, fabrication labs (fab-labs), maker centers, and micro-manufacturers. Many hackerspaces and maker centers have a more educational and community-oriented mindset and aren't interested in acting as manufacturers at the organizational level. However, most of these organizations are member-driven and would allow maker members to join the Unum network and use the facilities produce products.

Initial research has also shown that several NYC-based maker spaces may be inappropriate recruits for initial implementation, given the price of real estate in many areas of the city, which limits facility size, machine allowances, and opportunities for expansion. In addition, many urban makers have already established lucrative business models that fully utilize the space for paying members and walk-in machine rentals. Demand for machine time seems to be high enough in major urban centers that makerspaces aren't interested trying out new and untested revenue lines, unless they can be conclusively proven to be more profitable than current business models. As a result, Unum is focusing on makers in the outer-boroughs of New York City, especially those located in Industrial Business Zones (IBZs) who can leverage city-sponsored tax-credits and direct business assistance from city agencies to support new business opportunities, as well as those located in Mixed Use Districts (MX) are allowed to co-locate a retail showroom on site and sell products directly from the shop.

Marketing Strategy

Our marketing strategy focuses on three important initiatives:

Recruiting Designers: We are currently developing partnerships with students from Parsons School of Design BFA Product Design and MFA Industrial Design

programs, to curate a collection for beta testing of the Unum d'app and web store. On-campus events, faculty, workshops, and product-oriented hackathons are being targeted for connecting potential design partners. Moving forward, Unum will leverage digital marketing channels to connect with designers, focusing on a strong social media and community blog to convey the unique benefits of Unum's business model.

Partnering with Makers: We have already approached makers in the New York City metropolitan area for research, reaching out directly to maker centers, fabrication labs (fab labs), hackerspaces, and micro-manufacturers who demonstrated strong interest in trying the platform once it was developed. We will expand our business development efforts by creating a strong brand and clear and concise literature and a digital presence that conveys both our partnership guidelines (around necessary machinery, materials, wages etc.) and the benefits of how Unum works for makers. We are also working to expand our reach into upstate New York, specifically the Hudson Valley area.

Raising Funding & Spreading Awareness: In order to develop Unum, we must recruit additional expertise to create the blockchain technology needed for testing and implementation. Therefore one of our primary marketing goals is to fundraise enough capital to develop a fully testable beta of the Unum blockchain d'app and webstore. We are currently pursuing community fundraising channels such as crowd-funding platforms, startup opportunities (incubators, accelerators, competitions, scholarships, awards) both within Parsons School of Design and in the wider New York City entrepreneurial ecosystem, and government and foundation-based grant funding for community maker spaces. There may also be a unique opportunity to build fundraising into Unum itself, through offering Unum investment tokens, a speculative financial asset that allows people to "buy shares" of the Unum blockchain using crypto-currency. These Investment Tokens could both be offered through a Token Sale and to Partner maker centers as part of a cooperative business model.

Pricing Strategy

Unum is not a low-cost provider of furniture, nor does it seek to compete with traditional manufacturers and retailers on price alone. As such, our goal is to provide mid to high-end products that are mass-customized and produced on-demand as a unique collaboration between designer, maker, and customer. We aim to be less expensive than current small-batch design studios (Hem, Design Within Reach) that are inaccessible to much of our target market, but will not be able to match large-scale retailers (Wayfair.com, Amazon, Ikea) on price alone. However, we are looking into how the blockchain can create unique pricing mechanisms based on demand, designer reputation, and customer rating as one way of increasingly accessibility to items over time. Over time, we hope to build an Unum community where customers can actively engage with designers and local maker partners, and will create incentivization strategies to drive customer participation on the website and blog.

Competitive Analysis

Primary Competitors

Our primary competitors are other platforms that directly coordinate distributed manufacturing relationships, Shapeways and OpenDesk.

Shapeways | https://www.shapeways.com/

Shapeways is the world's leading 3D Printing marketplace and community. They enable anyone to make, buy, and sell products with 3D Printing. All Shapeways products are designed by their community members, some of whom offer freelance design services. All designs are made in their two "Factories of the Future" in Long Island City, NY and Eindhoven, Netherlands. They also work with manufacturing partners around the world through their Global Partner Network, to enable printing in more materials.

While 3D printing has a lot of promise for the distributed manufacturing of parts, homegoods, fashion accessories and more, the current builds require a lot of post-production, making it difficult to facilitate in a distributed manner today. Shapeways addresses this issue by locating all production in one location, but allowing a distributed global community of designers to list their items on the marketplace. This model helps the organization ensure quality, standard production of designs on a variety of materials through coordinating institutional knowledge of production processes in few physical factory locations. However, they are not truly a distributed solution in that they don't work with a distributed network of partners for fabrication (they do it in their own factory) and hence can't locate production around the customer, eliminating the economic and environmental benefits from supporting local

economies and reducing transportation of materials and finished products.

OpenDesk | https://www.opendesk.cc/

Opendesk is a global platform for local making. It can be used to download, make and buy work space furniture. They support a global network of makers and a collection of furniture by a range of international designers. Because that furniture is designed for digital fabrication, it can be downloaded as a digital file and made locally — on demand, anywhere in the world. Opendesk demonstrated the existence of already existing distributed manufacturing solutions and allowed us to interview NYC-based makers who worked with their designs and make one of the designs ourself to identify potential competitive advantages we might pursue. Opendesk is a strong competitor because of their wide maker network and curated list of design partners. However, their designs are not able to be fabricated on-demand in small quantities, their business model doesn't allow for incentivizing makers to test and share the manufacturing information that would make this possible. For this reason, they primarily focus on commercial versus retail product runs that require several identical items to be made. In addition,their main base of operations is in the United Kingdom, making them unfamiliar with American laws, customer segments, and business practices.

Secondary Competitors

Unum indirectly has many competitors emerging within the blockchain industry. Several new ventures are exploring how the blockchain can disrupt a variety of sectors, and two companies in particular indirectly compete with Unum in that they are building blockchains to address similar issues around intellectual property or tying physical resources to digital records.

Bitmark | https://bitmark.com/

Using the blockchain protocol, Bitmark supports a peer-to-peer property system built on the open-source Bitmark blockchain that enables the issuance and transfer of property titles for digital assets, for which the chain of ownership and attribution can be authenticated by anyone. Bitmark is similarly exploring how we might coordinate both intellectual property and ownership using the blockchain protocol. However, their focus is currently still on purely digital ownership of digital assets, and doesn't address making physical copies originating from a single digital asset.

SlockIt | http://slock.it/

Slock.it brings the benefits of the Blockchain to real-world objects (blockchain + Internet of Things). Slock.it considers the sharing economy, the industrial/maker/manufacturing space, supply chain management, maritime contracts and shipping, energy and clean energy, and smart homes to be the main areas their technology can be leveraged and is working with startups in various sectors to build proof of concept solutions. Slock.it is similarly trying to identify real-world objects on a digital blockchain, for the purposes of exchange, management, and transparency of access and ownership.They may be an indirect competitor or a potential technology partner, as their blockchain could meet some of Unum's unique needs.

Opportunities

Unum provides several unique benefits to designers, makers and customers with the blockchain providing a unique value-add for each audience. Through helping these stakeholders, Unum also benefits communities.

Designers | Unum allows designers to leverage an online global distribution channel for products that can be manufactured anywhere with digital fabrication tools. This helps them get their products to market even if they don't have the initial capital or facilities to manufacture it themselves. Unum can eventually even enable multiple designers to collaborate on one design and each be compensated for their contribution or coordinate the modification or remixing of designs where each new version created and sold pays-out all contributors back to the original designer.

Makers | Unum provides a new revenue line for existing maker centers and a unique business model that can help more maker centers open shop with a guaranteed sales pipeline. The platform uniquely compensates makers who test product builds and create/share digital manufacturing kits by paying them a testing fee each time the product is fabricated in the future. This finally makes it practical and profitable to produce digitally fabricated products on-demand within a set range of customization options.

Customers | Unum gives customers access to globally designed products that can be mode locally, supporting authentic, quality and responsibly manufactured products that are affordable for a wider variety of consumers. Unum also makes a product's lifecycle transparent, allowing customers to make informed

decisions and helping them be more aware of the economic consequences of their consumer choices.

Communities | By prioritizing on-demand production located around customers, Unum creates new opportunities for local and regional circular economies to compete with massive, global and corporate-owned economies of scale. Since customers can have globally-sourced designs made locally, Unum allows for consumer choice while circulating rather than extracting the value of their economic activity, keeping local money local. In addition, by providing a secure and scalable way for existing makerspaces to grow and new makerspaces to open, Unum supports a virtuous cycle of economic democracy and community prosperity that re-orients the monetary and cultural value of production and keeps money flowing through circular economics at the local and regional level.

Risks

The biggest risk Unum faces is that the blockchain d'app will not be easily understandable nor accessible by designer and maker partners. Blockchains are valuable because the tokenize value. A token is a digital asset that is valuable in and of itself, or a representation of any other asset that can be traded on a digital ledger with specific rights and purposes. This is very counter-intuitive given today's centralized databases and can be difficult in practically implement with partners who have a range of technical literacy. We are hoping to solve for this by focusing on makers who are more tech-savvy on average than business owners in other industries.

Another risk is that Unum's products will end up being too expensive at the end of the production process. As testing continues, we have realized that in order to pay maker staff a fair wage, the price of products will be much higher than a similar good at a retail outlet like IKEA. This means Unum will have to work extra hard to compensate for the higher price by promoting the unique collaborations, environmental sustainability, and support of community artisans that Unum enables.

Since Unum is based off an emerging technology that is not yet well regulated, we also risk issues of future laws and regulations that could make blockchains impractical or even illegal. It is unknown how current tools to manage intellectual property rights like licenses, patents, copyrights etc. will work with blockchains, as well as existing contract law to handle disputes.

Operations & Implementation

Business Model

Unum consists of two separate businesses, the Unum blockchain d'app and the Unum web store. The goal of Unum overall is to operate as a 'thin platform' that has a little control over the relationships between makers and designers as possible. The role of Unum is twofold: to curate and promote designs through the Unum web store, and to intervene in any contractual disputes between designers and makers using the Unum Blockchain D'App.

The Unum Blockchain D'App

We are looking into how Unum Blockchain D'App can be registered as an incorporated Worker cooperative in New York State, given the unique possibilities of the blockchain investment model. When maker partners are recruited, they can potentially be employed by this organization, making them co-owners of the business. Maker partners and their dedicated employees working on Unum orders can be allowed to vote to elect a board of directors when enough partners have joined the system, and eventually gain additional participation in the management of the firm.

Instead of distributing additional profits through this structure, employees will be given Unum Investment Tokens, which will be a speculative financial instrument the changes in value with its demand. These employees also act as the miners in Unum's blockchain d'app, approving transactions through proof of stake consensus algorithm. Owners of Unum Investment Tokens can exchange them on cryptocurrency exchange sites for their current value in any major national currency.

The Unum Web Store

The Unum web store will be set up as a private company owned directly by Unum's founders and registered as an LLC or S-Corp in New York State (I am also looking into B-Corps and L3C's). Any employees Unum hires directly will be employed by this company and paid in standard USD.

Revenue Model

Unum will earn money in two ways. It will collect a transaction fee on all purchases made and coordinated through the Unum blockchain. This transaction fee will be deducted in USD before the customer payment is translated into Unum Tokens. The company will also

earn passive investment through our majority share of Unum Investment Tokens. As the value of Unum as a company rises, the value of the Unum Investment Tokens will also rise. These tokens can be exchanged for national currencies on a cryptocurrency exchange.

Branding & Digital Identity

A Pinterest was used to collect images from similar brands and types of design that inspired the Unum Style. A mood board was created by Audrey Fox which helped her to develop brandin assets including a color palette, logos, and layout precedents for the Unum web store.

Implementation Next Steps

Progress is currently being made on a full-system experience prototype of all front-end touch points for the Unum Platform (web store, Design Dashboard, Maker Dashboard, Unum seals). System tests are being arranged with several partners:

- Designers from the BFA Product Design and MFA Industrial Design programs at Parsons School of Design
- Maker staff in the Parsons Maker Center
- Customers that will be recruited through an online survey and can test the web interface remotely (while in video-chat with the testing team) or on-site in New York.

This experience prototype will be completed using furniture designs from AtFab, who has given Unum permission to use and modify their designs for testing, if the production process is well-documented and credit given accordingly. Throughout this process, designs and style guidelines will be developed to information the curation of the Unum webstore. In addition, student, faculty and alumni designers who meet Unum's design aesthetic and who are working with CNC furniture and organizational units will be recruited to curate an initial collection for the Unum web store.

Unum is also coordinating with the blockchain company Consensys to discuss the specific technical requirements of the Unum blockchain d'app. If the next round of user tests goes well and fundraising is possible, the next stage of implementation would be to recruit a blockchain developer to develop the blockchain d'app and smart contracts necessary to coordinate the relationships between designers and makers. Unum is also applying to competitions, incubators and accelerators who can offer funding and resources to help drive the project forward.

Management Team

Dana Martens is an experienced designer and project manager with a background in social innovation, economic development, and launching startups. She is currently researching how the blockchain can enable new economic relationships, support cooperative business models, and create a true sharing economy. Dana is responsible for operations, business management, fundraising, and recruiting blockchain partners and maker clients.

Audrey Fox is a talented brand manager and UX designer with experience in digital fabrication, and sustainable production. She is currently researching how digital fabrication can be harnessed to disrupt traditional manufacturing models and global supply chains. Audrey is responsible for graphic and web design, branding, product specifications, and recruiting design partners.

We will recruit a full-time industrial design teammate experienced in a range of digital fabrication tools and have already approached several Parsons students who expressed interest in participating after graduation. We are currently recruiting BFA Product Design students for our initial catalog of designs for the Unum web platform and will also contract a blockchain developer to build the backend for our platform.

Appendix 5

Buckminster Fuller Design Application

Overview: Please provide a 50-word summary of your initiative and its mission. How would you describe your work in one or two sentences? (50 words)

Unum is a revolutionary platform that uses blockchain technology to connect makers, designers, and customers peer-to-peer, without intermediaries. Our mission is to create an effective framework for the future of distributed manufacturing, which relocates fabrication around consumers, and supports more sustainable, transparent, and community-driven production.

Problem Space: Please describe the critical need(s) that your initiative is designed to address. (200 words)

As we have seen in many other industries, once things can be done on a regular computer, they can be done by anyone. Today, digital fabrication tools like 3D printing, CNC routing, and laser-cutting have allowed the manufacturing industry to go digital as well, transforming not just the way things are done, but who is doing them, and democratizing how we produce, share, and consume products. Physical objects now begin as designs on a screen, and increasingly these designs are being shared online, not just by corporations and factories as in the past, but between regular consumers too, opening up new possibilities for a more distributed form of manufacturing and supply chains. However, equity and intellectual property remain very important issues when it comes to creating, sharing, fabricating, and selling physical products based on digital ideas. For this reason, there is a critical need for infrastructures and value networks that can coordinate trusted contractual relationships directly between customers, designers, and makerspaces, without the need for a third party platform. Unum utilizes blockchain technology to provide a cheap, shared resource that can support distributed making, creating a true sharing economy spurred by the Maker Movement.

Context I: Please describe the systemic failure that has given rise to the critical need(s)? (200 words)

While the digital revolution created amazing new ways to create and distribute information and content, the Internet of Information has serious limitations when it comes to fostering trusted relationships that allow people to equally exchange assets of value (money, intellectual property, identity) in a peer-to-peer fashion. For this reason, we relied on trusted third parties (banks, social media platforms, governments) to act an intermediary, and while they usually did a good job, we now realize that they also undermine our privacy, capturing our data for commercial gain and national security. Over time, this reliance on intermediaries has caused a system-wide imbalance of power, transforming traditional capitalism to a new platform where a handful of companies and platforms appropriate the economic and political benefits of decentralized networks and distribute them asymmetrically. As a result of this systemic failure, we have seen increasing wealth-creation, but also falling standards of living and growing social inequality. This model has become so pervasive that it is hard for us to even imagine how our digital future could be organized differently, or what new paradigms could exist for an equal decentralization of our business and economic relationships.

Solution(s): Please describe the specific solutions/strategies/models you are proposing to address the critical need described above in detail. (200 words) -

Unum addresses the critical needs outlined above through combining two emerging technologies, the blockchain protocol and digital fabrication, to begin creating a system-level paradigm shift in how we understand value and exchange when it comes to manufactured products. Already, digital fabrication tools make it easier for anyone to create products from art to furniture to electronics. Like the Internet Revolution, The Maker Movement, has harnessed these tools to decentralize and democratize how we produce,

exchange, and consume products, creating new opportunities for entrepreneurs, artists, and consumers around the world to collaborate in a more equitable and empowering form of manufacturing and production. However the makers movement is relatively new and disconnected, limiting the scale and impact of distributed manufacturing concepts. Unum solves for this issue by using the power of the blockchain to build trusted contractual relationships between designers, makers, and customers, allowing them to connect peer-to-peer to exchange products and value without intermediaries. Instead of an Internet of Information, the blockchain allows for an Internet of Value that is founded on trust and allows any asset from money to intellectual property to be stored, moved, exchanged, and managed without any powerful intermediaries.

Context II: Please describe what the systemic impacts would be if your approach were successfully implemented at the appropriate scale. How does your initiative address the key social, cultural, economic, ecological, and technological factors required to transform "business as usual" in your chosen area of impact? (200 words)

Unum uses the blockchain to create create a much-needed infrastructure that allows for already existing innovations in digital fabrication to scale into a sustainable circular economy for the New York metropolitan region. Our research has shown that consumers want local, sustainable, and authentic products that they currently can't afford through traditional manufacturing models and can't yet produce or co-create themselves since makerspaces are not fully utilized as part of a distributed manufacturing model, nor are they accessible for most people. When fully implemented, Unum will allow makerspaces (fab labs, maker centers, micro-factories etc.) to easily connect with both global designers and local consumers directly, innovating around out-dated, resource-intensive, and opaque traditional manufacturing supply chains by re-orienting production locally. This new model creates a virtuous circle of systemic impact through sustainability, economic empowerment and community-oriented investment and growth. Unum eliminates the needs for a global supply chain for raw materials and finished products, it supports a new manufacturing paradigm that prioritizes local labor, materials, and education, and it engages customers as co-makers, giving them both a sense of pride in having helped make something and transparency into where, how, and by whom their everyday products are made.

Location: Please describe the geographic scope of your initiative and where your base of operations is located. (50 words)

While we believe Unum can eventually become a successful global model for blockchain-enabled distributed manufacturing, we are initially focusing on the New York City metropolitan area and its outlying suburbs. Our base of operations is located in Brooklyn, New York.

Implementation: Please outline your implementation plan. What are the critical success factors you must achieve and what are the biggest risks facing your initiative? How do you plan to mitigate these risks and overcome any potential barriers? (250 words)

Our plan is to finish building and testing a full-system experience prototype with potential partners identified through our research. After testing front-end touchpoints, we will be able to validate the key information requirements the blockchain will need to manage for each party. We will use these core requirements to identify the best blockchain model (custom or adapted from an existing platform) and hire a blockchain developer to work with us and create a test blockchain environment to drive a fully functional system prototype for user testing. Throughout this process, we will continue to recruit design partners from Parsons students, alumni, and faculty with the aim of curating a collection of products for the platform launch. Our goal is to pilot our service in the first quarter of 2018, working out of The Parsons Making Center. As demand grows, we will recruit client maker centers into our business model as well as present our work at local conferences and makers' events to build interest.

Our criteria for success is an intuitive user interface for customers, a simple submission and compensation process for designers, and a clear definition of the roles and responsibilities of maker clients on the blockchain. The biggest risk is clearly showing how the blockchain adds transparency, immutability, and auditability to managing contractual relationships without overwhelming stakeholders with technical details. We are mitigating this issue by centering consensus on the blockchain around maker clients. Customers and designers can interact with the platform like a conventional website.

History and Vision: Please tell us what inspired your initial vision and how it evolved? What is your long-term vision (i.e. the "preferred state" towards which you are working)? (200 words)

Unum began with a story about the future. Co-Founder, Dana Martens participated in a design fiction exercise imagining a future economy where people earned income from collaborating on digital designs and their physical manifestations. What began as fiction quickly became real as she explored the impact technology is having on our current economy and how it's already empowering people to create and share everything from music, to movies, to art online. She was introduced to the blockchain as an exciting way to reimagine how these relationships could work in a more decentralized fashion, leveraging the full power of the internet to truly connect people peer to peer. Dana shared this passion with co-founder Audrey Fox, who was studying how digital fabrication could revolutionize product design to be more sustainable and community-driven. Together, we decided to explore how the blockchain could connect the players in the maker's movement, creating a new paradigm for future manufacturing. Like the story, we envision a future where people are paid for contributing ideas as micro-entrepreneurs, not their time as employees. We envision a future technology that can help people self-organize in more flexible and organic business relationships. Where Uber is owned by cab drivers, where Amazon is just a market for artisans' goods. We believe in a future where business is shared between real people, not aggregated by abstract corporate entities.

Compare and Contrast: Please explain what is unique about your strategy? Compare and contrast your initiative with at least two other current projects or groups working to address the same critical need. Please list these projects or groups by name. How is the work you are doing or your approach and strategy different from these two other initiatives within the context of the Fuller Challenge criteria? (200 words)

Unum is unique because it uses the blockchain to coordinate trusted intellectual property management. AtFab, a design firm who uses CNC fabrication tools and networked manufacturing to provoke a new way of designing, making, and buying things is also trying to address this issue. They proposed Design/Fabrication stores to curate digitally fabricated goods alongside the maker's crafting them. They manage designs and compensation beforehand and coordinate trust by co-locating customers and makers. Another organization is OpenDesk, a global platform for local making that allows customers to download, make and purchase office furniture. Individuals can download design files for free if used non-commercially or OpenDesk routes them to pay local makers if they don't have access to fabrication tools. This model builds trust by paying designers upfront fees and additional fees only if a design is fabricated by makers. If someone downloads a file directly, tracking is impossible as is ensuring the non-commercial license granted was not violated. Unum is inherently different from these models because it uses the blockchain to exchange intellectual property and compensation directly between stakeholders, removing the need for a platform to manage individual transactions or to ensure trust by locating everyone in the same space.

Impact: Please describe who or what is or would be most affected directly and indirectly by your initiative? How do you measure these impacts? Please explain in detail how you track, measure, and/or calculate impact (please include any specific quantitative metrics, if applicable) (200 words)

Our goal is to make distributed manufacturing viable for designers and makers, and easy to access for customers. We will create direct impact by providing makerspaces a new revenue model as well as allowing designers to earn passive income from their ideas. We will create indirect impact for customers, who have more sustainable and personal purchasing options and for the communities makerspaces are in. Unum gives makerspaces a new type of business that requires hiring and training additional employees to meet demand. Digital fabrication jobs pay well over minimum wage nationally and provide education in important skills that can be leveraged over a variety of sectors and/or help prepare people for entrepreneurship. Below are specific metrics we will track:

Quantitative

- Number of Designers Onboarded (tracked in platform)
- Total Revenue earned per Designer and for All Designers (tracked in platform)
- Number of Makerspace Clients Obtained (Tracked in platform)
- Number of products purchased through web platform (tracked in platform)

Qualitative

- Monthly check-ins with makers measuring demand management, revenue earned, and usability
- Quarterly Interviews with Designers to assess platform usability issues and new features desired
- Follow-up surveys sent to each new customer asking about the purchasing experience and satisfaction with final product

Budget: Please describe how your initiative has been funded to-date and how you plan to ensure its financial viability. Please include (if applicable): your top 5 funding sources; your annual project budget; if different, your total annual operating budget; and a multi-year budget projection. (200 words)

To date, we have been able to work on Unum unpaid as part of our studies at Parsons. We plan to fund Unum through a mix of community fundraising and non-equity grant/venture funding through early-stage incubators and competitions in New York City. As Project Manager for the Impact Entrepreneurship Initiative at the New School, Dana is intimately acquainted with a variety of social impact funding opportunities. Below are the top five funding sources we are currently investigating:

- NYC Media Lab Combine Program - Grant of $25,000 for high potential media/technology concepts
- Future Cities Accelerator, The Rockefeller Foundation & Unreasonable Institute - $100,000 grant for early-stage organizations with the potential to create deep and lasting impact for vulnerable US populations at scale
- Echoing Green Fellowship - $90,00 annually for 2 years, health insurance, and professional development funds for early-stage startups and innovative ideas
- Kickstarter - Raise $50,000 - $100,000 in exchange for free products or Unum tokens
- Blockchain Specific Funding - There are several opportunities to sell investment shares or tokens for seed-funding. We are investigating how we can leverage this unique model and if it works with our other blockchain needs.

Team: Please provide us, if applicable, details regarding your current team and any plans to expand it in the future. Please include short descriptions of team members' experience and qualifications as they relate to their ability to implement your proposal, and list (if applicable) the number of full-time and part-time employees and volunteers who contribute to your initiative. You may also include details about organizational/institutional partners committed to the success of your initiative and the nature of that support. (200 words)

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We are supported by industrial/product design faculty at Parsons School for Design and Consensys, a venture production studio building new end-user tools for blockchain ecosystems.

We will recruit a full-time industrial design teammate experienced in a range of digital fabrication tools and have already approached several Parsons students who expressed interest in participating after graduation. We are currently recruiting BFA Product Design students for our initial catalog of designs for the Unum web platform and will also contract a blockchain developer to build the back-end for our platform.

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