AN ANALYSIS OF 3D PRINTER USERS AND THEIR NETWORKS IN THE SILICON VALLEY

A Project Report

Presented to

The Faculty of the Department of Anthropology

San José State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Arts

By

Armando Ayala

December 2015

The Undersigned Graduate Committee Approves the Project Report Titled

AN ANALYSIS OF 3D PRINTER USERS AND THEIR NETWORKS IN THE SILICON VALLEY

By

Armando Ayala

APPROVED FOR THE DEPARTMENT OF ANTHROPOLOGY

Dr. Roberto González, Department of Anthropology — Date 10/28/15

Dr. Charles Darrah, Department of Anthropology — Date 10/30/15

Dr. J.A. English-Lueck, Department of Anthropology — Date 10/30/15

ABSTRACT

AN ANALYSIS OF 3D PRINTER USERS AND THEIR NETWORKS IN THE SILICON VALLEY

By Armando Ayala

3D printing is an emerging technology that has the potential to impact various economic and cultural domains including e-commerce, manufacturing, and medicine. While we have reliable indicators that the use of this technology is rapidly expanding, many researchers and companies are seeking to know more about how 3D printing is being used. Specifically, this study was contracted by a hi-tech Silicon Valley startup company to explore the networks, attitudes, and imagined futures of 3D printing users. The study consisted of 14 individuals who lived within a 50 mile radius of the Silicon Valley and fit at least one of three user types: (1) consumer-line 3D printer users; (2) online 3D printer users; and (3) non-users. Interviews were conducted to learn about participants' networks, experiences with 3D printing technology, and imagined futures about how 3D printing technology might develop in the future. Key findings suggest that embodied interactions with 3D printing technology were significant to participants' appropriation of this technology, participants often gained a sense of empowerment from 3D printing, and participants' intentions for printed models altered their perceived functionality. The following report details the theoretical and methodological considerations that concerned the research design. The report also describes key insights, discoveries, and outcomes that resulted from the application of the project.

ACKNOWLEDGEMENTS

Being the first in my family to obtain a post-graduate degree is a collective accomplishment: It is a culmination of the love and support of my mother, fathers, siblings, cousins, partner, friends, and teachers. It was done with the intention to provide added cultural and social capital to the future generations of my family and my community.

The love and unconditional support of my family was especially important for me as we lost a very dear and young member of our family to cancer during the apex of my program. Completing the degree while also working and grieving would not have been possible without my partner, my mom, and my sisters. I dedicate this achievement to my nephew Christopher Morales as a tribute to his memory and his legacy that emphasized the act of transforming sorrows into acts of love, creativity, and hope.

I would like to acknowledge Dr. Roberto González for encouraging me to enroll in the Applied Anthropology M.A. program, introducing me to the CEO that contracted this project, and for his guidance. I would like to thank Dr. Chuck Darrah for inspiring me to pursue the field of design anthropology and for his thoughtful and direct feedback during the revision process. I give thanks to Dr. J. A. English-Lueck who provided me with a platform that allowed me to develop my skills as an ethnographer and technologist. I would also like to thank Christopher Avery who provided me with mentorship about my research design and the field of UX.

TABLE OF CONENTS

Introduction

This report documents the processes of an applied ethnographic project that I produced for Andrew Laurence (a pseudonym), the CEO of a high-tech startup company in the San Francisco Bay Area. The startup's central product consisted of an iPhone Operating System (iOS) mobile 3D scanning application that synthesized sets of photographs into high-resolution 3D models. The application created 3D models of people, objects, and environments. Prior to starting this project, I had been interested in researching the impact of personal digital technology on American culture, especially its impact on California's Silicon Valley. My initial review of the literature focused on the problematic consequences of digital technology use including addiction, stress, depression, isolation, and social anxiety (See: Van der Aa, et al., 2008; Demetrovics, Szeredi, & Rózsa, 2008; Sueki, 2013). The literature that I reviewed was mainly quantitative; therefore, my initial research interests were focused on generating qualitative ethnographic knowledge about issues of problematic Internet use. For instance, I had an interest in examining the different ways that people practiced "smartphone mindfulness," a construct that I experimented with to describe the cognitive process of restraining smartphone use during perceived inappropriate social settings (e.g. a dinner date). As my interest evolved, so did my perception of the relationships between people and Internet-based technologies. The holistic approach of anthropology, which encourages the consideration of various, and often contrasting, viewpoints about a topic in one ethnographic study (LeCompte & Schensul, 2010), encouraged me to examine broader questions about the use of Internet-based technologies. I shifted my focus from questions about problematic Internet use to questions about how Internet technology

could be framed through anthropological theories about human tools. I wondered how anthropological theories of tools, the appropriation of tools, and cultural changes associated with tools, could generate insights about Internet-based trends and developments. Apart from negative consequences, the benefits and utilities of Internet-based technology were obvious, so I became more interested in exploring the meaning derived from these technologies by users. In sum, I wanted to explore the different ways in which people used Internet-based technologies and to examine what these technologies meant to them. Furthermore, I was intrigued to explore how people might frame Internet-based technology as an indicator of social progress and personal empowerment.

A key experience that significantly influenced my approach to researching technology was when I assisted on an anthropological practicum under the direction of professor Jan English-Lueck. The practicum consisted of an applied ethnographic project, led by the Institute For the Future in partnership with members of the Google Innovation Lab for Food Experiences, which examined food systems and food networks in the Silicon Valley. During my work on the project, I witnessed firsthand how Silicon Valley technologists designed products and services around their perceived influence in local and global communities. To illustrate, one of the participating company's mission was to end world hunger and many of their engineers and other employees felt they had the knowledge and determination to make that goal a reality. I learned that Silicon Valley was a place where technologists discussed "moonshot ideas" (e.g. bringing Wi-Fi to undeveloped African countries by weather balloons) to signal to their peers that they were insiders. Expressing one's optimism about the possibilities of technology was a shared cultural value amongst many technologists. Silicon Valley leaders promoted their

company culture as a model for other American and foreign companies to emulate. Through these experiences, I became exceedingly aware that Silicon Valley would continue to have significant impacts on global and local societies. It became evident that an understanding of Internet-based technology use by consumers would be incomplete without also examining the proprietors of technological products and services: Silicon Valley technologists.

My graduate advisor, Roberto González, and I discussed my interest in doing research related to Internet-based technology use. He was associated with Andrew Laurence (pseudonym), a CEO of a high-tech startup company who was looking for interns to help him uncover data about video game use and 3D printing. González introduced me to Laurence and this introduction laid the foundation for what would later become my project.

My first interaction with Laurence was over a phone call. He mentioned that he had been in the early development stage of his startup company, which was based on an iPhone application that worked as a mobile 3D scanner that synthesized sets of photographs of people, places, and things into high-resolution 3D models. His initial business goal was to formulate a revenue model for his product within the video game market. The first request that I received from Laurence was for me to conduct a marketing research project about the video game industry to derive actionable marketing insights. I had very little knowledge or experience of market research, so I reached out to my committee for advice about how to quickly expand my knowledge on this field. In doing so, English-Lueck was able to connect me with Christopher Avery, an applied anthropologist and graduate of the SJSU Applied Anthropology Master's program, who

was working in the marketing and design research field. He was able to offer me information about industry standards regarding qualitative marketing and human-centered design research. Avery's advising helped me establish a viable direction for my applied project. Laurence called me midway through my research design to inform me that the company had changed its course of action; he wanted to target the 3D printing market instead of the video game market. He was prompted to pivot the company towards this market after he was able to successfully print 3D models that were generated with his company's application. Laurence informed me that pivoting was an important and common business process for early stage startups. When startups pivot, it means they suddenly abandon prior business strategies for new ones. Pivoting occurs when founders feel that the current strategy is failing or when another strategy appears more viable (Reis, 2014). This sudden and challenging change was my first taste of working in a volatile startup context. I quickly refocused my efforts and began the design of a research project to examine the practices of 3D printer users.

I frame this endeavor as an ethnographic market and design research project. I used rapid ethnographic methods to establish a better understanding of the emerging 3D printing market using an emic approach. In addition, my project produced findings that were useful for the company's human-centered design directives. As an applied anthropology venture, I focused my project goals on satisfying the client's needs rather than my own academic interests. Nevertheless, many of my initial academic interests in technology were helpful in formulating effective research questions. I completed my research design by the late summer of 2014. The following week I began my interviews and data collection, which ceased towards the end of January 2015. The data were

analyzed and compiled into a deliverable in late January. The deliverable consists of two parts. The first section is comprised of findings related to the participants' networks, user experiences, and imagined futures. The second section includes a marketing strategy, campaign ideas, and a summative chart of the project's findings. On February 20, 2015, the deliverable was completed and presented to Laurence.

Anthropology is a discipline that encourages critical assessments of societal domains including those of industry, consumption, power, politics, and economics. The influence of critical theories and approaches on anthropology has made it a dynamic field, and some academic anthropologists have espoused ethical concerns of anthropological application (See: Price 1998, Mosse 2005). I was aware that some anthropologists attached a stigma to applying the discipline in business as being a "dirty" endeavor, a euphemism for being ethically perilous (Sunderland & Denny, 2007 p. 31). Because of these concerns, I undertook my research with great mindfulness of ethical research practices. Ultimately, I followed the American Anthropological Association's code of ethics and succeeded in designing and conducting a research project that my advisors and I found to be ethically sound. The main objective of this report is to demonstrate the processes of thinking and practice I underwent, as an applied anthropologist, in conducting applied marketing and design research.

Problem Statement and Research Approach

As stated previously, Laurence and the rest of his company's team wanted me to conduct a study that would add to their understanding of the emerging 3D printing market. More specifically, they wanted me to learn more about 3D printing users' attitudes and experiences and use this information to provide marketing and design strategies. In considering the stakeholder needs, I concluded that the research questions would require me to employ conceptual frameworks from the fields of human factors engineering, more specifically user experience (UX) research, and marketing research. Laurence wanted me to uncover information about 3D printing users to generate design directives for his product (i.e. a UX problem) and to develop strategies for acquiring more users (i.e. a marketing problem). My understanding of these two fields was vague, so I reviewed literature in both fields to better distinguish the key differences between each. Market research is a vast field that consists of theoretical frameworks, methodologies, and processes that are used to analyze existing markets and consumer patterns to solve commercial problems or increase the commercial success of products and/or services (Aaker, David, & Kumar, 1998). User experience research is a component of human factors engineering that is aimed at generating insights to improve the appeal, efficiency, and usability of a product (Albert & Tullis, 2013). User experience researchers achieve design insights by examining the meanings, feelings, and attitudes that users have about particular products, and by conducting usability tests wherein researchers observe representative end-users as they interact with, and use, products (Albert & Tullis, 2013). The term UX research can also encompass ethnographic and participatory design methods used to formulate new product or service

ideas, (see: Wasson, 2000; Sleeswijk Visser, Van der Lugt, & Stappers 2007). Laurence was interested in learning more about the current *usability* (a significant domain of UX research) of 3D printing technology. Usability is an integral domain of research and product developmet within leading high-tech companies. It is in a high-tech company's best interest to design their products with usability in mind because it can provide advantages over a leading competitor's product that users find difficult to use. According to Nielsen (1994), the usability of a product (e.g. Instagram) can be measured by five main components: (1) ease of learning; (2) efficiency of use; (3) ease of remembering; (4) number of errors by users; and (5) enjoyment of use.

In sum, market research is used for generating *broader* understandings of consumer behavior through the focus on data that informs a company about specific market segments, including competitors' sales, profit margins, and predictive sales analytics, while UX research is often used for guiding the design of products by researching the direct interactions between end-users and products or prototypes. As different as these fields are, integral overlaps exists between the two. To explain, consider that broad market research data can inform companies that their users are gravitating towards a competitors' product and UX research can uncover specific reasons why. Also, products that facilitate rewarding and reinforcing user experiences often generate their own word-of-mouth marketing. Considering this overlap was important in my case because Laurence wanted me to effectively target a specific user group and also discover how to best tailor his product for them. My review of UX research and marketing research was helpful in designing and applying my ethnographic project within a Silicon Valley startup setting. Although I drew inspiration from these fields, my

anthropological training remained central to my research design. Furthermore, ethnography is utilized in both marketing and UX research, if not with variations (see: Wasson, 2000; Sunderland & Denny, 2007).

In determining my research design, I had to deal with the emergent nature of 3D printing technology. Because consumer-line 3D printers were not as widespread as other personal high-tech products (e.g. smartphones), most of the 3D printing marketing literature I acquired consisted of quantitative forecasts of revenue patterns related to this market – qualitative or demographic information about 3D printing users seemed scarce, if non-existent. According to Mariampolski (2006) ethnographic market research is effective when little is known about the potential consumer. Therefore, I designed a research plan consisting of a rapid ethnography to examine 3D printing consumption patterns of individuals who lived and worked in the Silicon Valley, a region well-known for early adoption of emerging technology (i.e. 3D printing) (English-Lueck, 2002).

The questions that would serve as the focus of my rapid ethnography were further developed and refined during a subsequent meeting with Laurence and his colleagues. After this meeting, I operationalized the client's UX and marketing research initiatives into three primary lines of questioning. First, how did users' use of media, their place of work or study, their places of gathering (e.g. clubs and churches), or their social connections relate to how they became invested and interested in 3D printing? Second, what were consumers' experiences with and perceptions of 3D printing? Third, what were consumers' imagined futures about how 3D printing might develop in the future? The methods section of this paper describes my process of formulating my research questions in greater depth. Additionally, the client and I agreed upon targeting three

assumed user groups: (1) consumer-line 3D printer users; (2) online 3D printer users; and (3) non-users. We framed consumer-line 3D printer users as separate from online 3D printer users because we assumed that these two groups might have differences that were important to Laurence's business needs. Specifically, users of online 3D printers had to wait for their models to arrive in the mail, while owners of consumer-line 3D printers had instant access to their models. We also wanted to learn about non-users' thoughts, feelings, and opinions about 3D printing to try and glean insights about potential resistance points and/or selling points to consuming this technology. I developed a research instrument that encapsulated and expanded upon the aforementioned three primary lines of questioning, which is also explained in greater depth in the methods section of this report. While I offered writing a project proposal for Laurence, he insisted on only using my research instrument as a proposal of the project; he told me that he simply did not have the time to read a formal proposal. Nevertheless, I wrote a concise proposal that included a timeline, number of participants, and sampling strategy in order to better organize and plan my project. After garnering approval from all of my project's stakeholders, which consisted of Laurence, members from his company, and my research committee, I began the project.

A multitude of rapid qualitative approaches to research exist (See: Beebe, 2014). Although I did not follow a specific model like Rapid Qualitative Inquiry (RQI) or Rapid Rural Appraisal (RRA), I did review literature on these methods and incorporated their foundational tenets to ensure a sound research design. Based on the tenets of Beebe's (2014) RQI, my objective was to acquire ethnographic data through a methodology that allowed for rapid changes in research focus and iterations in research design, something I

knew I might have to do in a volatile startup environment. The overarching ethnographic research goal was to generate rich descriptions of participants' worldviews and 3D printing practices. The second section of the deliverable is comprised of marketing strategies grounded in the research findings and in frameworks from Moore's (2014) Silicon Valley startup industry standard *Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Customers.*

Format of this Report

The format of this project report consists of five sections. The first section, "Background Information", is comprised of information about 3D printing and the typical funding acquisition strategies of Silicon Valley startups. The 3D printing material in this section briefly explains the key differences between consumer-line 3D printers, high-end 3D printers, and online 3D printing services. This material is important for understanding the client, the participants, and the project, in their respective contexts.

The second section, "Research Design and Methodology," describes my process of designing and executing my research project. This section also explains the experiential knowledge I gained from this endeavor related to methodological considerations about applied anthropology in market and design research. Furthermore, this section explains the challenges I encountered as a result of doing applied anthropology for an early stage startup, and how I overcame them.

The third section, "Analysis," focuses on my analysis strategy and on how stakeholder needs influenced my analytical process and outcomes. Although some strategic insights are omitted due to proprietary rights, this section does provide real case

examples of how ethnographic research findings can be used in market and design research settings.

Section Four, "Delivering the Report," describes the process that I undertook in developing my strategy for presenting the deliverable to Laurence and others in his company. More specifically, this section explains how I presented anthropological findings to a business audience, and the lessons I learned therein. Additionally, this section describes the outcomes of my applied project and the project's ultimate reception.

The final section, "Reflections," offers my reflections on how working as an anthropologist in the Silicon Valley provided me with unique constraints as well as advantages. This section also describes how my interactions with people and places in this region, co-mingled with my personal history, forced me to think about the area and the high-tech industry in new ways. These reflections were compelling to me, and I included them in this report because I feel that they might be relevant to readers, especially applied anthropologists.

The report ends with appendices that include: (a) the project informed consent document; (b) the project interview instrument; (c) a letter from Laurence stating his receiving, and intended use, of the project deliverable with redactions; (d) the project deliverable with redactions; and (e) the deliverable PowerPoint with redactions.

Section One: Contextual Information

This section outlines key aspects of 3D printing technology that are important for better understanding the context behind the research design and the project's findings. Section one also includes a short segment that explains how Silicon Valley startup companies garner investment funding and direct their business development. The topics covered on the business practices of startups are included to provide context for the applied project, and are not exhaustive discussions of them. My research was designed and bounded by two key challenges commonly faced by early-stage Silicon Valley startups: scarce funding and time. In sum, it is critical to include information about the project's parameters that were a result of its business context.

3D Printing

Before providing a brief history of 3D printing, it is important to define and explain what 3D printing is. 3D printing is a general term that encompasses a variety of techniques and technologies that offer a range of capacities for producing objects in different materials under computer control (Campbell, Williams, Ivanova, & Garrett 2011). Most machines that are considered 3D printers utilize a process called additive manufacturing, which uses the laying down of successive and thin layers of material to make objects (Campbell et al., 2011). The successive layering of 3D printing distinguishes it from subtractive manufacturing in which material is removed by grinding or carving. One line of currently available consumer-line 3D printers is the MakerBot. MakerBot models usually consists of a box-like clear glass outer shells, temperature controlled beds, and extruders. A MakerBot extruder is similar to the inkjets of paper printers, but instead of extruding ink, the extruder heats plastic from a spool and

successively layers the melted plastic onto the printer's bed. The extruder layers the plastic in the fashion of pre-existing digital 3D model file, under computer control. Once the layers are completely laid, the finished product is left to harden into a shape in the likeness of its parent digital 3D model file.

The first 3D printers were created in the 1980's to assist in rapid prototyping. Rapid prototyping is the process of creating fast and cost-effective prototypes of products (Jacobs, 1995). In 1986 Charles Hull invented the process of stereolithography, which consists of using ultraviolet light to harden successive layers of material (Hull, 1986). From the inception of Hull's stereolithography to now, the 3D printing industry has undergone significant changes and developments. Two general lines of 3D printers have emerged; there are high-end professional 3D printers that range anywhere from $25,000 to $1,000,000, and there are consumer-line 3D printers that range anywhere form 200$-$2,000 (e.g. MakerBot). These are averages based on participant interviews and informal background research; it is possible for the ranges to exceed these presented averages.

Based on my fieldwork and research, it appears that there has been significant growth in the use of 3D printing by consumers in the past three years. One 3D printing event that generated national press coverage was when Cody Wilson posted a video on YouTube titled "The Wiki Weapon" where he disclosed the plans that he and his friends had (they called themselves Defense Distributed) to design and share files of 3D printable firearms and other weapons. Because of its illegal and innovative content, the story was picked up by major media sources like Forbes and Vice. The significant aspect of this story was that Wilson, who was at the time a law student, was able to successfully shoot three bullets using a firearm that he designed and 3D printed in plastic. One of the most

provocative aspects of this story was that Wilson created a firearm without any regulation by the U.S. gun registry. Once more, Cody Wilson stated in his "Wiki Weapon" video that he wanted to freely distribute firearm files over the Internet, without any restrictions. This is not to suggest that the potential to 3D print weapons was causally related to the recent expansion of the 3D printing market, but that Wilson's video, and the media coverage about it, effectively demonstrated that 3D printing was functional, viable, and full of society-altering possibilities.

3D printing was first designed as a tool for industry, not as a product for consumers. Nevertheless, this paper focuses on consumer-line 3D printing practices, products, and services. The 3D printing consumer market encompasses the printers and printing services that are targeted to the average consumer, and it is this particular market segment that my research was focused on. As mentioned earlier, my project frames the 3D printing consumer base into two broad categories: consumer-line 3D printer users and online 3D printer users. Consumer-line 3D printers are usually purchased for the home, but might also used in professional settings. As stated above, the objects that are 3D printed are actual replicas of their parent digital files, known as computer aided design (CAD) files, which are then often converted into .STL files (Campbell et al. 2011). CAD models consist of three-dimensional digital designs created using CAD software like SolidWorks, AutoCAD, and SketchUp. CAD models can be created using CAD software, or can be downloaded as files from file sharing sites like Thingiverse. Once a user has a CAD model, she can print it with a 3D printer, as long as it fits within the parameters of the printer (i.e. objects must fit within the confines of the printing bed and extruder arm).

To provide helpful visual aids, the consecutive two figures illustrate the process of how CAD models are used to make 3D printed objects. The first symbol on the left of Figure one is that of a 3D CAD model, the second symbol is similar but is known as an .STL file. CAD models are usually exported as .STL files because .STL files have a universal format that can be processed by most 3D printing slicing software. 3D printers usually have 3D printing slicing software, shown by the third symbol, that "slices" the .STL file into tiny cross-section layers. Slicing software creates a 3D pathway for the extruder to follow as it successively produces and lays layers of filament. The fifth symbol shows a MakerBot (AM stands for additive manufacturing) printer and the last symbol shows the 3D printed object. The cup shown on the far right is typical of the range of quality of objects printed by consumer-range 3D printers; these objects are typically one color and made of plastic. Also, objects printed on consumer-line printers often have reduced accuracy and resolution, meaning that they might have rough exteriors or might misrepresent some of the fine details of the original CAD model.

Figure 1. A diagram of the 3D printing process. Retrieved from: Campbell, et al. (2011) on 05/25/2015

Figure 2 illustrates the key mechanisms and structures of typical consumer range printers; nevertheless, many high-end printers also follow a similar structure. The

filament, as shown below, is usually plastic, which comes in spools, and is fed into the nozzle (e.g. extruder) by a feed roller. The extruder liquefies the plastic by heating it and lays the liquid plastic filament in successive layers upon bed, also known as a Z-stage.

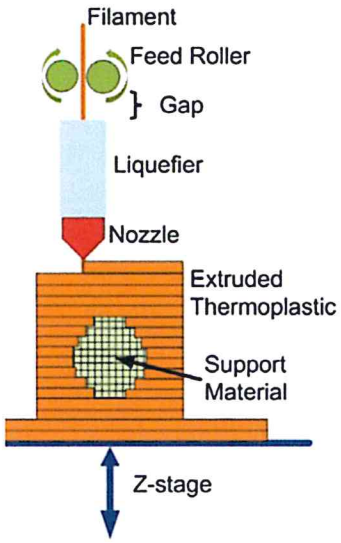
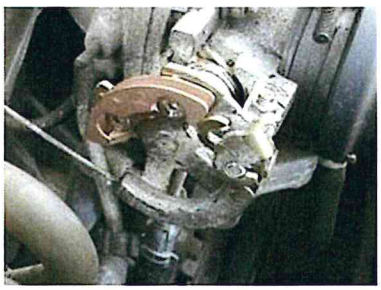


Figure 2. A diagram of the usual components found in 3D printers. Retrieved from: Campbell, et al. (2011) on 05/25/2015.

Most high-end professional printers, such as the popular brand Stratyses, are typically out of the reach of the average U.S. consumer because of their price range ($25,000 - $1,000,000). However, online 3D printing websites offer services that allow users to print objects made by high-end printers. Online 3D printers include web-based companies like Shapeways, Sculptio, and iMaterialize. These websites are unique in that they facilitate online stores where CAD designers, who are often skilled in CAD design at a professional level, are able to sell their design concepts. The buyers do not have access to designers' actual CAD files, they are only able to purchase objects made in the likeness of designers' CAD models. Therefore, buyers pay for the design concept and the

materials of the model, the designers are compensated for their design concepts without having to distribute their CAD files, and the company is compensated for printing services and materials. As opposed to models found on websites that offer users free and downloadable pre-designed models like Thingiverse, websites like Shapeways create new market opportunities for CAD designers; the price range of items from websites like Shapeways can vary anywhere from $10 to $300. Also, because online 3D printers like Shapeways operate using high-end printers, designers and consumers are able to make and buy products in a wide range of colors, sizes, and mixed materials, including ceramics and metals. High-end printers are also able to print models at a high definition of resolution, meaning that they are able to represent the original digital CAD model file at extreme accuracies. I have only briefly discussed the most basic 3D printing mechanisms, as many other mechanisms exist within consumer-line and high-end 3D printers .



Figures 3-5, from left to right: (3) mechanical object for automobile engine; (4) artistic sculpture; (5) gold-plated bracelet. These figures illustrate the range and types of objects that can be made using online 3D printing websites. Retrieved from: http://www.shapeways.com/create?li=nav on 05/25/2015.

In conclusion, the business and consumer 3D printing markets seem to be expanding. As a case in point, business experts predict a tripling in industry growth within the next five years ("Forecast: 3D printing market value", 2015). Research informants shared with me that engineering firms, like aerospace organizations, utilize high-end printers that can make robust and accurate parts for spacecrafts. Tuan C. Nguyen published an article in the Washington Post in 2015 about the Chinese trend of 3D printing houses and buildings; the highest 3D printed Chinese building was five stories tall. Instead of plastic, massive Chinese 3D printers utilize cement and lay the material in successive layers under computer control. Medicine has also begun utilizing 3D printing and medical researchers and engineers have created their own branch known as *bioprinting* (Ozbolat, 2015). Bioprinting is the use of a medical 3D printer to successively layer cells or tissue in order to repair damaged tissue or to create transplantable organs (Mironov, Reis, & Derby, 2006). It appears that 3D printing has the potential to disrupt existing networks of markets and can generate problems for branding, ownership, and regulation. In addition to just printing and building models, software applications have been made available that instantly create digital CAD models of everyday objects, like Laurence's product. Keeping these cases in mind, it seems that research that examines the social impacts of 3D printing holds import for academic institutions, public organizations, and industries.

Silicon Valley Startups

For many residents, the Silicon Valley is both a place and also a term for the information technology industry (English-Lueck, 2002). Physically, the Silicon Valley is comprised of San Mateo county and Santa Clara county (English-Lueck, 2002).

Nevertheless, the IT industry exists beyond these two counties and permeates much of the San Francisco Bay Area. For example, IT has a large and growing presence in San Francisco, which hosts Twitter and Uber's global headquarters, as well as in Oakland, which host's Pandora's and Ask.Com's global headquarters. In the following paragraphs, I will briefly explain some of the typical funding processes of Silicon Valley startups in order to provide information that explains the project's context.

Startups, both in the information technology (IT) sector and beyond, usually begin with an idea for a new or improved product or service. Funding is required in order to develop a new enterprise. If a startup founder does not have enough personal funds to launch her startup, she must seek the added capital of investors. Investors can be private donors, seed investors (AKA angels/super angels), or venture capitalists (VCs). The term "seed investors" refers to those who invest money during the first of many funding stages of a new venture, known as a "seed round" or "pre-series A round." Angels, individuals who invest their own money into start-up companies, will invest smaller amounts of capital like $25,000-$50,000 (Tauli, 2008). Venture capitalists, who invest more than angels, usually hold their first investment at a minimum of $3,000,000 (Horrrowitz, 2010). The Silicon Valley startup sector is well known for relying on venture capital to achieve success. An article in the San José Mercury news stated that in 2014, 57% percent of the nation's venture capital investments went to companies in the San Francisco Bay Area (Somerville, 2014).

Fundraising for startups usually progresses as a series of successive rounds. Successive rounds are based on quarterly and yearly assessments of company progress. Startup leaders attempt to progress their company from the seed round to what is known

as a "Series A" round, and reaching the series A round implies that the company has received its first large VC investment(s) (Newton, 2001). In each successive round, the company should be worth significantly more than in previous rounds according to what is known as a valuation. The process can repeat itself until the company reaches an initial public offering (IPO), or until it becomes acquired by another company.

Venture capital is different from typical business loans because VCs purchase percentages of companies' equity, which can be lucrative when sold as public stock after an IPO, or as equity of increased value during an acquisition. Company equity is usually purchased and sold in units of shares also known as stock. Impeding financial failure of a startup is usually signaled when a startup has a "down round," meaning the company's valuation did not improve and VCs did not invest any further capital (Marmer et al., 2011). If the company fails, the founders are not required to repay spent VC funding, but founders might return any existing remaining VC capital. In speaking with many SV entrepreneurs, it was common conception that 90% of IT startups fail, and this number was reported in Marmer et al. (2011).

Now that the typical fundraising processes of start-ups have been discussed, it is important to explain how start-up companies often conduct their business development under such uncertain financial conditions. One term used often in the Silicon Valley is "lean." The term comes from Eric Reis' (2014) book titled *The Lean Startup*, which outlines a business and product development framework for startups. The word lean also refers to the scarce financial resources that startup founders are forced to operate their business under. Eric Reis (2014) defines a lean startup as any enterprise or organization that is under extreme uncertainty and limited resources. During my time at the startup, I

heard company leaders apply the term lean to all aspects of the business. Namely, there were lean budgets, lean market research, lean development, etc. This term effectively expresses the dynamics of start up companies: company founders and early employees must be exceedingly creative and strategic in the way they manage responsibilities, accomplish goals, and make business development decisions because failure might be one miss-step away. Silicon Valley startup founders are evidently aware of the 90% high-tech startup failure rate and I noticed in my fieldwork that this perceived risk was very integral startup business practices. In particular, the early-stage startup employees I met often worked for significantly lower rates than the industry standard in exchange for company equity, which may or may have not resulted in a successful return on investment. Startups also placed a great strain on employees. Low budgets meant small teams, so startup employees often worked on a wide range of tasks, often far outside of their areas of expertise or experience. In my case, I was expected to work on this research project and was also asked to assist on projects of content creation, sales, and fundraising. It was also apparent that many start-up employees worked more hours than they would at an established company as a way to make up for the low availability of labor.

Section Two: Research Design and Methods

The research that was used to create the deliverable consisted of a rapid ethnographic study that included 14 participants. The research methods consisted of participant observation, in-person interviews, and phone interviews. Interviews were open-ended, but were guided by the interview instrument. This section will discuss the process by which I developed my research process, including my sampling strategy, my

instrument design, and how I immersed myself in aspects of participants' 3D printing-related culture.

Rapid Ethnographic Methods

As Beebe (2014) demonstrated, the array of different rapid qualitative methods is vast. I initially expected to find a specific method, such as Rapid Qualitative Inquiry (RQI), that was designed specifically for ethnographic market research and design. Instead I found guidelines for how to conduct ethnographic research in business and design settings (See: Sunderland & Denny, 2007; Mariampolski, 2006). The most challenging aspect of designing my research was the process of balancing my research objectives with the logistical realities of a startup. Specifically, the project had to be completed quickly to keep pace with the client's rapid business development objectives. Furthermore, Laurence's company had not begun its seed-funding round and because of this, he was unable to provide me with any funding. Due to my lack of research funding, participants would not be compensated for their participation.

If I had failed to produce the research data in time, the company could have very well pivoted to another market and it would have left my research unused and unapplied. I did my best to adhere to a rapid timeline, which led me to consider questions about balancing the need for rigorous quality and rapid throughput. Another significant challenge I faced was in understanding the strengths and limitations of my sample size goal of 10 participants (I was able to reach 14 participants), which was smaller than what was often used in academic qualitative research (see: Mason, 2010).

When I initially questioned the validity and utility of qualitative data generated through rapid research methods, I referred to the literature on both applied and academic

ethnographic methodology. I thought it useful to establish a strong understanding of standard ethnographic research methods before designing and conducting a rapid version of these methods. In addition, my undergraduate training was in the field of psychology, more specifically developmental psychology, which emphasized the use of positivistic and quantitative research methods. Subsequently, I compared and contrasted my ethnographic research design to conceptual frameworks of quantitative psychological research methods. I considered the meaning of validity and reliability in ethnographic research. My first methodological question was about sampling processes. Three things were obvious to me that seemed problematic. First, I would recruit participants within my native environment, which led me to explore questions of convenience and bias. Second, I decided upon a sample size objective of at least 10 participants, and I was unsure about the potential strengths and weaknesses of this sample size. There were many reasons why I decided upon a goal of 10 participants. I had to balance a four-month deadline for data collection (the timeline was reflective of the client's needs) with my full-time graduate academic coursework, my weekly commitment of 20 hours of work at my secondary occupation, and non-existent funding. What would my sample be representing and how could I keep it diverse and purposeful? Lastly, how would I have known if I had gathered enough data from each participant? These questions are explored in greater depth in the following section.

Sample Strategy and Characteristics

I was keen on understanding the strengths and limitations of my proposed sample size. This project's research focus was on users who lived within my local environment. In addition, my client provided me with a tight timeline; therefore, I decided that the best

and most efficient recruitment approach would be to recruit participants through my own social network. However, doing so would have presented problems of bias and convenience in an experimental design or other psychological quantitative research designs (see: Goodwin, 2009). My undergraduate background in developmental and experimental psychology placed an emphasis on probabilistic sampling methods, so I compared the sampling strategies with the sampling strategies of ethnographic research. In reviewing the literature, it became apparent that bias related to convenience is uniquely framed and dealt with in ethnographic research. Schensul and LeCompte (2012) defined convenience samples, or reputational samples, as any group of participants who are readily available to the researcher and who possess the qualities relevant to the study. The authors did not frame convenience samples as problematic. According to Schensul and LeCompte (2012), anthropologists can take advantage of such sampling methods when the research is exploratory and the results are not intended to be representative of the general population. Since my work was both explorative and not intended to be generalized to the population, I found this sampling method appropriate and convenient, especially regarding my financial and temporal constraints. The bulk of my sampling process consisted of asking people within my network if they knew of anybody who used 3D printers. Schensul and LeCompte (2012) described this practice as a chain referral selection. Therefore, my sampling strategy was more of a chain referral selection strategy than a convenience strategy because 13 of the 14 total participants were found through referrals (one participant was an acquaintance from an undergraduate course). Moreover, all of the participants were purposely selected to satisfy the parameters of the pre-defined groups.

I explored literature about how to establish a sample size for a rapid qualitative study that would produce valid, meaningful, and applicable data. In qualitative studies, sample sizes and sampling strategies are designed upon the assumption that they will produce adequate saturation (Guest, 2006). Saturation refers to a point in the qualitative research process when continued data collection from subsequent participants of a well-defined group ceases to produce any new information or themes (Guest, 2006). Thus, I questioned how congruent my research design was with theories of saturation. Bernard (2011) stated that there is growing evidence to conclude that 10-20 knowledgeable participants can help a researcher accurately identify the core themes of a well-defined group's lived experiences. I kept in mind that my goal was to produce meaningful and actionable data and produce a rudimentary picture of the Silicon Valley 3D printing user base (well-defined group) that could be improved upon in later research projects. I learned that applied research is based on client goals, which also impacts the quality and depth of a research project. If a company says they want a study done in three days, the applied anthropologist must do her best to meet this deadline all the while producing valid data with actionable results, even if that means utilizing a limited sample size.

In reading design literature, I found that some design studies utilized sample sizes with less than 10 participants, especially when the objective of a study or experiment was to generate design ideas, rather than reach probabilistic conclusions. In particular, Ljungblad and Holmquist (2007) asked people about their marginal practices related to special interests (e.g. caring for exotic pets and designing aquariums) and used aspects of each participant's idiosyncratic interests to develop ideas for new prototypes. Ljungblad and Holmquist's (2007) sample was not intended to reach saturation or generate findings

that were representative of a specific population or group, but was instead intended to assist in the generation of new product ideas. Sample sizes below 10 participants were also encouraged in applied usability research literature. According to Rubin and Chisnell (2008), usability test studies can be successfully performed with four or five participants because tests with four or five participants will identify 80% of the usability issues. This sample size is strategically important for businesses that are often constrained by budgets and rapid timelines. Similar to Ljungblad and Holmquist's (2007) research goals, my intention was not to establish statistical significance or ethnographic saturation, but instead to derive actionable insights from users' feelings, imaginations, and experiences to formulate new marketing and product ideas. In reviewing these works, I became more confident about using a sample of at least 10 participants. I also decided I would do my best to gather more participants if it would contribute to an understanding of a cultural theme, if it would provide product insights, and if time and resources allowed.

Although saturation was not a primary goal of my research project, I did keep track of the themes that emerged in participant interviews and I assessed the degree to which specific themes emerged multiple times. This was helpful in trying to maximize the diversity of my research sample and also helped me track participants' unique experiences, opinions, and imagined futures.

Conceptual Criteria Formation

One important aspect of ethnographic research is the ways in which qualitative researchers define sample variability. In quantitative research designs, research processes are based on normative evaluations (i.e. statistical analysis) (Howell, 2013). However, ethnography is often employed for exploratory studies (Mariampolski, 2006), which was

the case in this research project. My conceptual criteria formation was further developed by noting repeating themes that emerged and by discussing the target participants with the client. According to Schensul and LeCompte (2012), noting the saturation of themes is not only useful to generate high internal validity about a group's lived experiences, but also to understand the components of a group's variability. To explain this better, consider that my first sample criterion consisted of seeking out participants based only on whether they had used consumer-line 3D printers. As the research process progressed, I noted that there were people who solely used online 3D printers, like Shapeways.com, and people who solely used consumer-line 3D printers. Furthermore, their experiences and feelings about the technology were dependent on these aforementioned use patterns. Thus, my sample criteria expanded and was refined as I learned to distinguish participants by their 3D printing use patterns. I also concluded that it would be important to incorporate non-users because they could provide interesting insights about media-based impressions about 3D printers and reasons why they had not been motivated to use 3D printing or had not had the opportunity to do so. LeCompte and Schensul (2013) have stated that ethnographic research often evolves and changes as it progresses and this was true for the research project and the sampling strategy.

Rigor in Rapid Ethnography

In addition to developing the sampling strategy, questions remained about determining what ethnographic research quality meant, regardless of sample size. My undergraduate quantitative training in psychology emphasized calculating the statistical power of a sample size and defined sound research findings as establishing statistical significance (Howell, 2013). On the other hand, anthropologists defined ethnographic

research quality differently, especially in the domains of reliability and validity. For example, double blind studies are designed as such to ensure that there is sufficient unfamiliarity between the participants and the test administrator in order to reduce the risk of bias (Goodwin, 2009). But in ethnography, researchers foster connections and relationships with participants, and LeCompte and Schensul (2013) defined objectivity as a practice wherein the researcher remains un-invested in the outcomes of the research. Since ethnography requires immersive practices that can foster intimacy between the researcher and participants, ethnographers cannot operate through the objective distance of an experimental study, but they can operate in a manner that is detached from the outcomes of the findings. Another key aspect of ethnography is the process of studying behavioral phenomena in natural settings and through natural temporalities. In essence, ethnography is not a method wherein researchers are able to control or tease apart variables, which is a key facet of an experimental design. Nonetheless ethnography *is* particularly useful in working with emergent phenomena that are not yet well understood.

The explorative and emergent nature of ethnographic methodology presented questions of reliability. Reliability, as defined in the field of psychology, refers to the capacity of a research project to produce the exact same findings when replicated by other researchers (Howell, 2013). In contrast, Schensul and LeCompte (2012) stated that reliability is not a necessary objective of ethnography because ethnographers often study events as they happen in natural settings and in real time, which cannot be recreated. Methodologies that incorporate reliability are advantageous in providing assumptions about causality, while ethnography can capture descriptively rich phenomenological data. Considering the advantages of ethnographic methodology, it was evident that reliability

was not needed to achieve our research goals, and seeking to establish reliability could have hindered them.

In addition to reliability, I also examined the topic of establishing research validity by ethnographic means. I wanted to achieve the best possible level of quality since the purpose of the research was to help the stakeholders make informed business decisions. Valid data would be necessary for the client to achieve a desired outcome. LeCompte and Goetz (1982) define validity (the ability to match our assumptions of the world with what actually exists within it) along two lines. The first is internal validity, which is the capacity of a researcher to actually observe and measure what she thinks she is observing and measuring. The second is external validity, which is the ability for a researcher to generalize her findings to other groups or similar conditions. For LeCompte and Goetz (1982), internal validity is a particular strength of ethnography, while external validity is not easily achieved by ethnographic methods alone. The authors suggest that internal validity is attained more easily by ethnographic methods than by most quantitative or experimental methods because of four key reasons. First, ethnographers' common practice of cultural immersion provides them with more time to assess whether their scientific assumptions match what is actually happening within a group or setting. Second, ethnographic open-ended interviews provide ethnographers with information that is not filtered through pre-designed metrics. Third, participant observation provides behavioral data of people within their natural setting, which is difficult to produce by a contrived experimental design. And lastly, ethnographers are encouraged to be consistently self-aware of their biases and positionality during their studies because of their immersive interactions with participants.

With regards to the company needs, it became evident after a review of the literature about ethnographic methods that my research objectives were achievable through a rapid ethnography. I would be able to generate data about users with a sufficient level of internal validity, which could be productive in generating marketing and design ideas. Specifically, gathering valid data about the selling points of 3D printing from actual users could provide leaders of the company and I with ideas for marketing objectives, including marketing campaigns and developing their brand's messaging. In the area of design, the findings of my research could also provide design directions grounded in documented user experiences, including suggestions about which features to test in future products. Additionally, the findings and speculations of the research project could be tested against quantitative measures in the future as a means of triangulation and to bolster their external validity.

In addition to providing valid and reliable data using rapid ethnographic methods, ethnography proved advantageous for me because of its flexibility. Laurence and I both had a realistic understanding of the rapid rate of change in high-tech trends. In other words, we knew that we were working with a moving target. Ethnography presented a significant advantage in this volatile context because it allowed for the collection of data within natural temporalities and cultural changes.

Generating a stronger understanding of the epistemological considerations of ethnographic methods was essential to designing a sound research design. Considering these questions in depth allowed me to recognize the strengths and limitations of my methods and about the ways in which I would use my data to make actionable strategies. While academic research places pressure on conducting empirical and rigorous research,

my research project had the same rigorous expectancy in addition to the pressure of rapid application and financial consequence. Since the recommendations one makes in applied research settings can significantly alter the course of a company or impact the lives of stakeholders, it becomes evident that applied research should be conducted with extreme attention to methodological details for ethical, professional, and evaluative reasons.

Participant Observation

Participant observation was both a means for me to gain a rich understanding of participants' lives and worldviews and a way for me to expand the sample size. My first participant observation experience took place at a genomics lab at a university within Silicon Valley. David worked as a physicist in these labs and invited me to see his workspace, current projects, and how he employed his son as a part-time intern. Because his research incorporated many engineering aspects, he showed me the ways in which his work related to his interests in 3D printing. In doing so, he gave me a tour of his lab and his equipment, including a machine that could slice apart DNA at a molecular level.

During my second participant observation event, I attended the Silicon Valley Forum (SVF) for 3D printing meet-up. The SVF is a collective of Silicon Valley technologists who arrange meet-ups around various emerging technology trends using MeetUp.com products. MeetUp.com is a company that provides a website and mobile application that allows users to create and facilitate events based on specific interests. This conference consisted of different up-and-coming 3D printing startups from the Silicon Valley and abroad. This event provided me with the opportunity to learn about the most advanced developments and trends within 3D printing, both in the Silicon Valley and abroad.

During the SVF meeting I met Sarah, a 3D printing jewelry designer. She invited me to her Shapeways.com party using the MeetUp application. The Shapeways party was my second and last immersive experience. This party took place at a bar in the Mission District of San Francisco. At this party, I met designers from many different genders, ethnic backgrounds, and ages. Designers brought in their products to discuss things they had learned and things they hoped to learn in CAD design and 3D printing. The meeting appeared to serve as a point of community contact and personal development for the designers. This experience was invaluable to my understanding of their practices regarding this technology. The group welcomed me as a researcher, and I was able to direct my questions to the entire group and gathered data using an informal focus group-like format.

The findings that emerged from these participant observation events are discussed in greater depth in the analysis section. It is important to note that the bulk of the data collected within the project was gathered during semi-structured interviews.

Instrument Formulation

As stated previously, the client's needs determined the design of the interview instrument. Along with meeting with the team to design the research instrument, I also met them to define and gather consensus on the project's scope. In addition to studying 3D printer users' networks, experiences, and imagined futures, Laurence had also asked if I could extend the project to include research about how users would interact with his company's product. I rejected the latter because I felt that it would be too large a scope in the context of my four-month timeline and non-existent budget. In doing so, I had to explain the key differences between marketing research and usability testing; studying

people's interactions with the product would be usability testing, and would require an additional and usability-tailored research approach. Therefore, I had to clearly communicate that the scope of my research would consist of exploring 3D printer users' networks, experiences, and imagined futures to generate insights and ideas for marketing and design initiatives. Moreover, I found it important to frame my project as unique from industry standard qualitative market research; my project was an ethnography that could provide meaningful insights for the marketing *and* design needs of a startup company. Positioning my project this way motivated me to seek out anthropological theories that would be useful in framing the client's research questions and in refining them.

My immediate reference to how anthropological theories could be applied to market and design research was Ian Hodder's entanglement theory (2012). Entanglement (Hodder, 2012) is an archeological theory that emphasizes the interdependence of people and objects, objects and objects, and objects and people. Entanglement is made up of four assumed interdependent relationships: (1) humans depend on things (HT); (2) things depend on other things (TT); (3) things depend on humans (TH); and (4) humans depend on humans (HH) (Hodder, 2012). I referred to entanglement theory specifically because it is a framework used for analyzing the relationships between people and things. Hodder's (2012) theory led me to consider how users' 3D printing practices could be linked to their networks. Thus, I decided that my primary method of analysis would consist of examining the aspects of users' networks (e.g. their media sources, their tools, their places of work and/or gathering, their social bonds) that were related to their use of 3D printing. It was assumed that examining users networks could provide me with information as to how users came to appropriate this technology, which could be useful

for Laurence's marketing goals. I was also inspired by Latour's (2005) Actor Network Theory (ANT), which emphasizes the importance of considering actors, systems, and agents of change as significant aspects of a network. Hodder's (2012) theory of entanglement challenges ANT's emphasis on removing all distinctions between people and object (and all other dichotomies) because Hodder (2012) has stated that momentary, but real, tensions exist between people and things. As an example, Hodder (2012) stated that in moments things have dominance over people (e.g. weather events) and at times people have dominance over things (controlling a computer). Apart from theoretical distinctions between entanglement theory and ANT, both of these theories promote a focus on the various linkages between a person and his or her environment, social culture, and material culture and the transformations associated with these linkages (Hodder, 2012). In my case, examining aspects of users' networks could provide data for generating new ideas about how to reach current 3D printer users and how to introduce new users to 3D printing. Accordingly, my interview instrument contained questions about how users were first introduced to 3D printers, their media sources, their demographics, their places of study or work, their places of gathering (religious organizations, clubs, etc.), their tools, and the their social connections.

The second main line of questioning that was incorporated in my research instrument was about users' attitudes, impressions, and preferences about 3D printing. Although the prospect of conducting usability tests was outside the scope of my project, I knew that it would be feasible and advantageous to gather information about users' current user experiences with 3D printing. Laurence's company could potentially utilize UX-related data to spur ideas about future UX studies or features relevant to their

product. In attempting to gather rich information about users current 3D printing experiences, I included questions that about users' interpretations of 3D printing quality, functionality, usability, and affordability.

The last main theme consisted of consumers' speculation about how 3D printing would develop in the future. This was inspired by anticipatory anthropology, which takes advantage of anthropological methods to formulate research-grounded speculations about possible impending changes in a particular society (Textor, 1985). My anticipatory questions served two purposes. First, I included these questions as a means to potentially generate speculations grounded in research about possible future developments and trends in 3D printing technology and 3D printing practices, which could be of use to the client for making business decisions. Secondly, I assumed that asking participants about the future of 3D printing might also reveal insights about their present-day practices, beliefs, and attitudes related to 3D printing. This included questions about how participants expected 3D printing to be used in the future and about the ways in which the technology would develop. I presented multiple drafts of my interview instruments to all relevant stakeholders before using it in my research. Once all of the stakeholders came to the consensus that the instrument was adequate, I began my semi-structured interviews.

Format of the Instrument

When I collaborated with the Institute for the Future for a project titled Sustainable Food Systems: *Farms to Firms to Families*, I was able to gain experience regarding the design and use of research instruments in applied settings. While on this project, I was under the guidance of English-Lueck, who led the formulation of the project's research instrument. This project helped me understand the techniques for, and

importance of, designing the instrument around stakeholder needs. For instance, I observed how English-Lueck regularly checked in with stakeholders, whose needs evolved and changed as the project evolved and changed. In doing so, she was able to successively modify the research instrument in ways that was successful in meeting the stakeholder demands. English-Lueck also utilized theories of anticipatory anthropology, and it served as my introduction into this subfield and my inspiration for incorporating aspects of it into the research instrument. Another key aspect that I borrowed from English-Lueck's instrument design was the process of asking less intrusive questions in the beginning of the interview and more intrusive questions towards the end. This process was congruent with training that I had in psychological group-leading processes wherein group leaders are instructed to follow a pattern of light questioning to heavy questioning in order to garner trust from the group and successfully encourage them to share their intimate feelings (Corey, Corey, and Corey, 2013). I did not have a way to objectively indicate whether questions were more intrusive or not; I ordered my questions from less intrusive to more intrusive by subjective means. Ultimately my intention was to increase the chances that participants would provide me with a rich description of their experiences, but regardless of order, the content of the questions did not change. The interview instrument can be seen in Appendix B.

Participant Interviews and Informed Consent

A total of eight semi-structured interviews that were guided by the instrument were conducted. Interviews were conducted at participants' places of work, in public spaces, or (in one case) by telephone. These audio recordings from the interviews were recorded and transcribed, except for two that were recorded manually as a series of notes.

I had many interactions with participants at events, like the Shapeways party and the SVF 3D Printing MeetUp. To keep track of the non-interview based interactions (The six remaining participants), I took detailed notes immediately after the events and wrote up a firsthand account that included paraphrases of conversations and my observations about these events. After my interaction at the Shapeways party, which was not recorded, I wrote up a series of notes about the experience, which served as texts of analysis. Interviews were roughly one hour long and participants were asked questions from the interview instrument that were relevant to their responses in addition to questions that emerged as a result of the interview. All participants granted their informed consent and all participants were over the age of 18. A copy of the informed consent form can be seen in Appendix A.

Section Three: Analysis

For my analysis, I utilized content analysis, which Berg (2001) defined as a systematic and objective coding scheme that can employ a variety of approaches in order to analyze qualitative data. My content analysis incorporated Glaser and Strauss' Grounded Theory (1967), which follows the three steps of coding text for themes, formulating theories based on themes, and validating those themes. I followed Glaser and Strauss' method of content analysis for two reasons. First, my main method of analysis dealt with interview transcripts, thus a method for analyzing text was needed. Second, I wanted to utilize a framework that was peer-reviewed and academically prominent. In the analysis, themes consisted of any information about participants' attitudes, values, and unique applications of 3D printing that were relevant to the research questions. In considering the emergent nature of ethnography (Schensul & LeCompte,

2012), I was drawn to utilize a balance of both inductive and deductive coding processes (Bernard, 2011). What I mean by this is that I allowed for unforeseen themes to emerge from the texts while simultaneously seeking new insights about our pre-established questions about users' networks, impressions, and imagined futures. Accordingly, I followed the question structure and I compared the different answers from participant to participant, both from transcribed interviews and recorded participant observations. One question was, "When was the first time you ever used a 3D printer." Most participants related their use of 3D printing to their jobs. Four of the eight participants who were interviewed first used a 3D printer at their workplace. Other users reported that they became users of 3D printing technology because they worked professionally in 3D design fields. These data implied that work, defined as either as a physical place of employment (e.g. the office of a startup) or as career types (e.g. 3D graphics) was an important aspect of how most participants were introduced to 3D printing. In sum, the questions elicited information that could be categorized usefully, and the variety of answers suggested new analytical categories. In particular, I categorized users' comments about how they became users of 3D printing (i.e. category), and then the theme emerged that work was an important point of connection to 3D printing for many participants (i.e. theme).

Although I did take into account the frequency of the responses in order to develop themes, I did not utilize any formal quantitative analyses of these themes because of the small sample size and because I wanted to represent idiosyncratic information generated from different participants that were relevant to stakeholder needs. The interview instrument was useful in gathering data related to the questions, and the themes were useful in understanding different meanings that ran across multiple participants or

meanings that were only true for one participant. During my content analyses, I also focused on manifest and latent content (Bernard, 2011). The first consisting of understanding explicit messages from the participants' statements, and the latter looking at implicit meanings in their statements, such as noting their tone or facial expressions.

Schensul and LeCompte (2012) stated that ethnographers should go beyond the mere selection and presentation of facts by *interpreting* the facts to draw meanings from them. Because this was different from my quantitative training, I utilized conceptual frameworks from hermeneutics, humanism, and phenomenology to assist me in interpreting the data. Hermeneutics is the discovery of meanings through the interpretation and re-interpretation of texts, including non-empirical texts like myths, speeches, and religious texts (Bernard, 2011). Using this framework, I looked for potential meanings in the raw data. I also wanted to better understand the role of empathy in ethnographic analysis. Humanism is a framework that encourages empathy. For instance, Bernard (2011) stated that humanism is the process of using one's own feelings, values, and beliefs to achieve insight into the nature of human experiences. Understanding more about humanism allowed me to recognize how the ethnographic analysis process, which often requires the researcher to interpret subjective material (i.e. feelings, attitudes, and preferences), is not opposed to a natural science of experience, but rather a practice of a natural science of experience (Bernard, 2011). The use of empathy to understand how others feel and think is not a hindrance towards scientific rigor; rather, empathy is a powerful tool for understanding and interpreting ethnographic data. Moreover, Bernard (2011) stated that phenomenological studies, including ethnographies, seek to produce convincing descriptions of phenomena, rather than explanations or

causes of them. Understanding more about hermeneutics, humanism, and phenomenology helped guide my analysis and helped me understand the strengths and limitations of my findings.

I was very clear and explicit to the client that my findings and interpretations were not generalizable and did not suggest any causal explanations. The intent of my analysis was to construct a phenomenology-focused account of participants' interview statements, practices, non-verbal cues, and material culture. The research project was intended to examine behavioral phenomena and produce findings with high internal validity. Future studies that include external validity as an objective (i.e., statistical analysis of 3D printing user demographics using a large *n*) could be guided by the findings and speculations from this foundational study.

In retrospect, I would have preferred to have the time and resources available to further validate my conclusions by asking participants for feedback about my interpretations of our interactions. But my inability to gather these additional data was a result of the constraints of the product development process. These constraints included tight timelines and a non-existent budget.

Actionable Findings About 3D Printer Users

The findings about 3D printer users were not intended to contribute to the general knowledge about 3D printer users. The findings were meant to provide the client with information that was relevant to their questions regarding the practices associated with this technology. This information was used for making marketing decisions and design decisions.

The most significant finding that emerged from the data was that the differences between experiences of online 3D printing users and consumer-end 3D printing users were much more significant than Laurence and I had previously assumed. About half of the participants (six of fourteen) had only used consumer-end 3D printers; the other half used online 3D printers. Once more, users of each group had distinct experiences and practices related to 3D printing that were relevant to increasing our marketing intelligence. The people who I met at the Shapeways party were all skilled CAD designers. They brought models to the party to share with me and other attendees (pictures can be seen on page eight of the deliverable, which is included in Appendix D). The attendees designed all of the models that were brought to the event. Participants were eager to discuss their design and iteration process. Six of the participants operated an online store through Shapeways.com. These six participants expressed to me the tediousness of the iterative designing-to-selling process. 3D printed objects often had manufacturing-based inconsistencies between their structures and their parent digital CAD files. Sarah made and sold decorative iPhone 6 Plus cases on Shapeways. She was frustrated when models sent back from Shapeways did not fit the iPhone case as tightly as she had hoped. She stated that models that were below her expectations of quality had to be re-designed and reprinted on the website at her expense, which sometimes took about three weeks for her to receive. She needed the objects to be of high quality in order to ensure that the buyers of her products form her online store would be satisfied with their purchase. Sarah's CAD designing skills were critical to making aesthetically striking designs and for adjusting models in such a way that they were optimized for 3D printing.

The users of consumer-line 3D printers did not express interest in CAD design. A majority (5 of the 6) of the in-person 3D printer users did not identify themselves as CAD designers, but all of the avid Shapeways users did. This was important because it inspired me to think about the possible reasons why non-users might be reluctant to engage in learning CAD design, and how our product, as a scanning and CAD rendering service, could provide designers with less work-intensive solution for creating 3D models. Samuel, a college grad had used 3D printers at his startup job, and he expressed that the aspect of having to design something on CAD software was one reason why he was not continuing to use 3D printers. He stated that his middle-aged father had recently purchased his first smartphone, an iPhone, and was able to use it quickly with ease and efficiency. Samuel expressed that he would be more likely to use 3D printing in the future if 3D printing could be as easy to learn and use like his father's iPhone. Samuel's statements were insightful because he had used 3D printing once, and had not been motivated to use 3D printing technology again. Considering these data, I speculated that perhaps skilled CAD designers were Shapeways.com's target consumer, and that users of consumer-line 3D printers might be less likely to identify as designers, and have usability issues related to their lack of CAD design skill. With this speculation in mind, I discussed different design directives and marketing opportunities with the client. We discussed how Laurence's product could potentially succeed by providing low-cost and user-friendly solutions for creating and printing 3D models, something that consumer-line 3D printing users might have taken advantage of if the technology had been more accessible.

In addition to their skill levels, I also examined social practices of online 3D printing users and consumer-line 3D printing users. Shapeways users utilized MeetUp.com as a way to interact with other designers, representatives from other 3D printing websites, and potential newcomers. Many of the Shapeways users stated that they had formal training in art school as CAD designers. Some of the users had been friends for years and experienced 3D printing as a hobby that brought them a greater sense of community. I saw a much smaller sense of community related to 3D printing amongst the users of consumer-line 3D printers. Colton, a mechanical engineer, used 3D printers with his children to make model rockets and his wife used the printer as a tool for making and selling cookie cutters. He expressed that his wife's cookie cutter business was successful because she was able to make unique shapes using his SolidWorks license, but expressed that he saw a need for a less complex and free version of CAD software, one that should also be more user friendly for novice CAD designers. CAD designers utilized social networking tools like MeetUp.com for a variety of reasons, but most importantly, meeting other designers was an opportunity to further develop their design skills. The theme that Shapeways users were highly skilled, while other users identified as being generally more interested in 3D printing than in CAD design, continued to emerge from my interactions. These data helped us make connections between our product as a 3D scanner, and the current lack of cost-effective and user-friendly 3D content creation tools. Although I cannot go into more depth regarding my actionable recommendations for proprietary reasons, I can say that these findings were effective and useful to my strategy design and recommendations.

All of the findings, along with excerpts from interviews, can be read in the deliverable that I have attached in Appendix D. My marketing strategies and other identifying information has been redacted to protect participant and client privacy.

Section Four: Deliverable Design and Presentation

When I first had a meeting with Laurence and other leaders in his company, I had discussed what my potential deliverable might look like. When I briefly mentioned including theory in the deliverable, they stated that they were only looking for concise and short descriptions of my findings, along with actionable recommendations. This was initially challenging for me because I was accustomed to using theory to explain my research design, methods, results, and conclusions. I had to identify a format for presenting my findings and recommendations in way that was concise and explained ethnographic findings to a business audience. While working as a contributor on the Institute For the Future (IFTF) practicum, I had access to a draft of a deliverable made by researchers at the IFTF (Avery, English-Lueck, & Hamamoto, 2014). I borrowed aspects of the draft's format for my own deliverable. What I really liked about the draft's format was that it was able to convey ethnographic insights in a way that was accessible to business audiences and people with little or non-existent social science training. Also, it contained poignant interview excerpts that supported the local theories posited by the researchers. Another significant aspect of the IFTF's format was that it made use of bold typefaces and visual aids to grab the attention of the reader. From my own interactions with Laurence and others in the company, I understood that everyone was incredibly busy and had little time to delve deeply into a long document. I kept in mind the user experience of the reader by borrowing the IFTF's style of using bold typefaces and using

it to highlight key sentences that would encourage the reader to take a look a the interview excerpts.

Capturing stakeholders' attention was important because I understood their preoccupations and their desire to move on to the next project as fast as possible. Rapid development was one of Laurence's key business objectives because he was concerned about competitors and he wanted to meet investors' expectations on time.

I included photographs of users' printed objects. Also I designed two charts, one that described the potential market needs that the company could meet and another that summarized important findings for further marketing and design research projects. I imagined how sections of my report might be used in business settings, like meetings or presentations, and I tailored certain segments of my report to be usable in these settings. Also, I kept in mind that my audience was not interested in how my findings might be validated by any other current findings, so I refrained from referencing any literature within the report, except a market research statistic and Berg's *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers* (2014). The deliverable was titled *Client Acquisition Memorandum: An Analysis of 3D Printer Consumers and their Networks.*

When considering how I would present the deliverable to Laurence, I thought it important to have an in-person meeting to review the primary findings and discuss the suggestions that I made based on the data. I also wanted to discuss in person how the data might be used, considering any recent business developments, and my future role within the company. I designed a PowerPoint comprised of 31 slides and I did my best to include what I assumed to be the most relevant findings for his business goals. Laurence

and I scheduled a meeting in San Francisco and we met on February the 22, 2015. A copy of the PowerPoint can be seen in Appendix E.

His initial reaction to my PowerPoint was one of impatience. I was rushed through the presentation and encouraged to focus mainly on the strategies than the actual findings. Laurence was not antagonistic or rude in the way he rushed me. It was clear that he wanted to educate me about his company culture, which emphasized a concern for strategies and key results, not methodology or contextual information. Laurence was pleased with the findings in that they provided preliminary data to the questions that he had regarding the potential user base, their preferences, their forecasts, and their networks. The deliverable was circulated to other key members of the company and it was successful in bolstering its business information about 3D printing users.

Results from the Project's Application

Eric Reis' *The Lean Startup* (2011) neatly frames a model of business strategy that is consistent with how many natives in the Silicon Valley startup scene do business. The premise of this model is that a startup by definition is any company or component of a company that is attempting to deliver a new product or service under extreme unpredictability. The stakeholders and I were following this model, except that we were also seeking to better understand the 3D printing market before developing any designs or products related to it. There were many reliable indicators that had predicted immense growth for the 3D printing market (see: "Projected size of the global market for 3D printing, materials & associated services in 2014 and 2018", 2014). As much as my report was able to identify potential user-centered entry points into this market, the report also indicated that the consumer market for 3D printing products and services was facing

challenges related to its expansion. Investors stated that many users wanted features out of 3D printing that were yet to be developed, or did not function exactly in the manner that users desired. An example of that emerged from the research when David spoke of wanting to have a 3D printer with a cost of $20,000 that could print models in vibrant and different colors, including various transparencies, a feature he had not been able to find in any currently available printers. Non-users had stated that the process seemed too complicated and were unable to identify need for the technology within their daily practices. The investors that our team spoke with where not optimistic about the company's entry into the 3D printing market because they felt that the technology was not being adopted as rapidly as they had hoped, which they defined as *traction*. During my project, *traction* emerged as an important word for the client and his company. They used the term as a catchall term to mean any type of rapid adoption from users, high user engagement in one's product, or anything else that might indicate success to potential VCs and investors. The investors' reluctance of this market, coupled with some of my findings, prompted Laurence to re-pivot his efforts and abandon the 3D printing market.

Although the results of my project did not result in any strategic action taken by Laurence or those in his company to enter the 3D printing consumer market, the findings *were* used to make informed business decisions. This project has accomplished two things. First, it assisted Laurence and others in his company in assessing whether the 3D printing market was a wise investment of their limited resources. When startup founders pitch their business strategy to investors, it requires founders to be confident in their strategies. This report helped Laurence evaluate this potential venture in a more informed manner as it provided added confidence in his business decisions. Even if VCs

were to give Laurence funding to pursue this market, Laurence's main goal would be to target the market that would provide the most and the fastest amount of traction, and he concluded that it would be difficult for his company to gain adequate traction in the 3D printing market. Secondly, this project now serves as internal literature on the topic, which could be utilized in the future. Laurence's company pivoted towards another market, but the company did not rule out the possibility of pursuing 3D printing in the future. Laurence explained to me that the most prudent strategy for startups with multiple use cases (the potential use and market of a product) is to first target the market with the most traction and subsequently leverage that traction to infiltrate secondary and tertiary markets. Thus, the data provided could very well be used in the future if or when Laurence's company has gained enough traction to re-target the 3D printing market. For high-tech startups, knowing when to do something is just as important than knowing how to do it. My report provided information for developing *how* to get into the 3D printing market and formulate user-centered designs, but it also helped Laurence realize *when* starting this venture would be optimal- which ultimately was not in the near future. Laurence was pleased with the quality of work of the deliverable. Because of this, he offered me employment and allowed me to craft together a position that allowed me to fulfill the current company needs and one that would allow me to improvise on ways to push the company forward. A brief letter stating Laurence's receiving and implementation of the deliverable can be found in Appendix C.

Section Five: Reflections

This section describes my reflections about my experience working in the Silicon Valley startup sector as an anthropologist, and the unique challenges and advantages that

I encountered because of my training. Furthermore, my anthropological training, and my personal history as a first-generation college student and second-generation Mexican-American, has forced me to think about the industry and the region in new ways. These reflections are included because they were significant aspects of my learning and they might hold relevance for readers, especially other anthropologists.

From Researcher to Creator

I was not offered a position at the company because Laurence wanted me to continue to do rapid ethnographic projects or because he thought my insights were extremely accurate; according to him, it was more because of my attention to detail, my ability to adapt quickly to his company culture, and my resourcefulness. The position I crafted and have been working in for the past three months is "UX Researcher." One word that summarizes the techniques and practices that have allowed me to thrive in a startup environment is: resourcefulness. My training in both psychology and anthropology provided me with a rich understanding of behavioral research methods and rigor. Additionally, my training in applied anthropology has helped me adapt qualitative research methods in a variety of settings, especially design research. Moreover, my training in the behavioral sciences has provided me with tools for reflecting upon my own behaviors and the behaviors of those around me, which I have used to my advantage when confronted with issues of ethics, workplace politics, and interpersonal communication. Working at Laurence's company has required me to learn many other skills that are unrelated to research.

Learning these additional and vital skills is where my resourcefulness has been critical. First, I had to learn the basics of usability testing. Upon my initial entry into the

field of UX research, I naively assumed that having a strong understanding of applied ethnographic methods would be enough to be competitive in the UX research field. After going to various UX research meet-ups and talking with other colleagues in the field, two things became very clear to me. First, it is common for UX researchers to spend the majority of their time utilizing a specific type of usability testing known as *moderated usability testing*. Second, although some UX researchers did utilize rapid ethnography and other immersive qualitative research methods, ethnography was often framed as an expensive research method that can only be conducted when sufficient resources and conditions allow. In learning this, it became apparent that moderated usability testing was the "bread and butter" of UX researchers, as a senior colleague informed me. Students from other fields, especially from graduate programs in human factors engineering and human-computer interaction often are trained in industry-relevant usability testing methods. Knowing how to properly conduct industry-standard usability tests were critical to my career in UX research. In order to learn industry-standard usability testing, I had to be resourceful and rely on literature, attend UX-related gatherings, and reach out to friends who worked in the field. My behavioral science training left me well equipped to understand the foundational conceptual frameworks from which moderated usability testing is based upon. Namely, how to interact with research participants to make them feel comfortable (i.e. building rapport), understand the limitations of qualitative data, analyze qualitative data (i.e. content analysis), and collect and interpret users' nonverbal behavioral data (i.e. participant observation). As I stated earlier, I did meet some UX researchers who worked primarily as ethnographers in high-tech, but they were still required to oversee many other types of UX research projects,

and a mastery of the various industry-standard UX research methods did appear to be critical to their career success. My advice to anthropologists wishing to go into this field would be to generate a deeper understanding and mastery of different industry-standard UX research methods in addition to rapid and design-based ethnographic methods.

Second, I have had to learn design and content creation skills. At a UX conference I attended, three top-level UX research directors from rapidly growing high-tech companies were asked the question: "If you had neither in your company, who would you hire first, a UX researcher or a UX designer?" All three directors stated that they would hire a designer first because designers can produce products and services, which was of primary importance for them. They said they viewed research as secondary because of its contingency on the formulation of products and services. One director stated, "You have to start with the product, otherwise there isn't anything to be researched; designers can make those products." Similarly, Laurence expressed to me that he wanted me to be creative and to take initiatives on assisting in the growth of his company, even if that meant venturing into engineering, fundraising, and product design. In doing so, I have started and led projects that required me to design. Particularly, I created multiple wireframes for an upcoming mobile product that the company is intending to launch. Wireframes are low-fidelity concepts that visually explain the structure and intended user-flow of a user interface. Wireframes serve two primary purposes. First, they assist in the communication of a product between researchers, designers, product managers, engineers, and other stakeholders. Second, they can be used as prototypes, or can be transformed into interactive prototypes, to be tested with

users to identify significant design inconsistencies prior to any expensive, and difficult to modify, engineering.

The significance of the linkages between my product design projects and my initial ethnographic project cannot be understated. Because the company was a startup of only four employees, including myself, there was a significant need for production, as well as research. These product design tasks required me to learn design software, specifically Adobe Illustrator and Adobe InDesign. Because I had no formal training in these software programs, I learned how to use them by watching tutorials on YouTube and by using online forums to download pre-made wireframe templates. In addition to deciding to initiate these design products, I was also required to complete these projects on rapid timelines. I went from not knowing how to use any design software to creating and testing five wireframe alternatives within two weeks. It is important to demonstrate the connection between where I started (e.g. ethnographer), to where I am now (e.g. UX researcher doing some UX design). I think that my career will continue to develop more towards the path of UX research, but I find my recent product design experience to be just as critical to my career success as my research skills. These product design skills allowed me to improve my perceived value at Laurence's company. My employment might not have lasted had I not been able to adapt and venture into product design, tasks that stakeholders perceived as critical to the company's growth. I have put into practice what one of my committee professors, Chuck Darrah, taught me in an applied anthropology class, "Producing, rather than just researching, helps you stay at the table longer!"

In addition to product design, I have also had to develop and refine my entrepreneurial and business skillset. For instance, I have had to attend various conferences to promote our product. I have pitched to investors for funding when senior members of the company were not available to do so. Pitching our company to VCs and investors required me to discuss finance, equity, and company valuations in a manner that is convincing and compelling enough to foment investment interest. Although I have received some business coaching from Laurence, I have researched and learned most of the business and finance knowledge on my own accord. I feel that my venturing into product design and business reflect the similar theme of positioning myself as a producer in addition to being a researcher.

Again, I think the word resourcefulness effectively summarizes my adaptive career practices. However, there is a key aspect of my anthropological training that assisted me in being resourceful: I approached the company as if it was an exotic culture that required my full immersion in much the same way an anthropologist would when studying an unfamiliar group. This ethnography-inspired perspective guided many of my adaptive actions. I subscribed to various blogs and email updates that informed of the latest news and developments related to startups, large high-tech firms, and high-tech investments. I asked individuals who worked in other companies to go to lunch with me so they could share stories with me about their work related experiences and knowledge. I watched films like *The Social Network*, television shows like *Silicon Valley*, and attended startup gatherings. I read articles about the careers of prominent Silicon Valley startup founders, like Jack Dorsey (Twitter) and Elon Musk (Tesla, PayPal, Space X). By approaching the industry in this way, I was able to amass a significant amount of

knowledge in a short amount of time. This knowledge acted as cultural capital that allowed me to effectively interface between people of various roles, including engineers, VCs, CEOs and CFOs. I was even able to garner interest from a leading Chinese entrepreneur and investor after both pitching the company's product to him and answering questions related to our financial goals.

It is not uncommon for applied anthropologists to find themselves in positions where they have to interface between different stakeholders who each have specialized types of knowledge and unique perspectives pertaining to relevant issues, projects, or enterprises. Interfacing with different stakeholders often requires applied anthropologists to supplement themselves with subject matter that is relevant to each stakeholder. Little (2013) conducted an ethnographic project to examine a vapor intrusion-related public health incident that occurred in Endicott, New York. In this study, the researcher interviewed Endicott residents' about their experiences of the negative health effects that they felt were a result of vapor intrusions caused by a nearby IBM laboratory. The author compared and contrasted residents' accounts of vapor intrusions along with the accounts of IBM associates and representatives of the Environmental Protection Agency (EPA). Those representing IBM and the EPA spoke from a position of scientific authority. For them, the validation of a vapor intrusion incident required specialized knowledge and high-tech equipment. The residents felt that the accounts and reports of both IBM and the EPA invalidated their firsthand experiences, more specifically IBM's and the EPA's interpretation of what caused the perceived high occurrence of cancer that plagued their neighborhoods. Little's (2013) research serves as an elegant example of an ethnographer who learned different types of subject matter in order to generate a better understanding

of relevant stakeholder perspectives, including stakeholders with specialized knowledge (e.g. the physics of vapor intrusion). In a similar manner, I had to develop skills and knowledge outside the field of behavioral sciences (e.g. finance, interface design, business development) in order to effectively interface with investors and others in the company and to improve my perceived value. In sum, I feel that my training in applied anthropology has given me an invaluable set of skills for not only producing actionable research, but also for making effective connections with different people to facilitate knowledge sharing, creativity, and action.

A Tale of Two Valleys

My ethnographic immersion in a high-tech startup, which allowed me to quickly garner information that helped me interface with various stakeholders, also motivated me to examine the industry and its broader context. Particularly, it led me generate questions about the economic boom of the high-tech sector, and the disparities in the San Francisco Bay area that appeared to coexist alongside it. It led me to perceive the high-tech industry and the region in new ways. The following section briefly summarizes these questions, but exhaustively exploring each topic is beyond the scope of this paper. Ultimately, my awareness of these issues is directly related to my training in anthropology, especially the field's emphasis on holistic considerations of social practices, social systems, power, and ethics.

A recent article in the SF Gate predicted that 2015 could be a historical year for the technology sector on Wall Street (Lee, 2015). In the spring of 2015, Uber (an SF-based startup company that offers private driving services from sharing economy drivers at the touch of one's smart phone) was valued at a staggering 50 billion dollars (La

Monica, 2015). That is higher than 80% of all the companies in the S&P 500, an American stock market index that averages the value of some of the U.S.'s largest companies (Meyers, 2015). This is just one example of the startups that have emerged with astronomical valuations in Silicon Valley; many other Silicon Valley startups have developed rapidly including Tesla, Instagram, and Lyft. Alongside reports of a recent high-tech economic boom, reports have also emerged of growing issues of economic disparity in the San Francisco Bay Area. For instance Kim-Mai Cutler wrote an article for TechCrunch that detailed the recent changes and cultural history of East Palo Alto, a traditionally affordable neighborhood for Black, Latino, and other minority residents (Cutler, 2015). With the advent of Facebook so nearby, East Palo Alto's real-estate has had a dramatic increase in its median value. The 2013 U.S. Census Bureau stated that Menlo Park's (Where Facebooks Global HQ is located) median household income was $112,262, which was more than double that of East Palo Alto's at $50,142. Cutler (2015) expressed concern that gentrification might occur in East Palo Alto in in a similar way that it has in other Bay Area minority communities, like San Francisco's Mission District.

Stories of gentrification and unaffordable housing are almost a daily occurrence in Bay Area media sources. In addition to gentrification, gender and ethnic diversity have been at the forefront of negative press about the economic disparities of Silicon Valley. Google's self-published 2015 diversity ("https://www.google.com/diversity/") report shows the majority of their workforce to be 70% male, 60% white, and 31% Asian. Latinos make up 3% of the workforce and Blacks make up only 1%. Unfortunately, other prominent high-tech companies share similar numbers (See Apple's and Yahoo!'s diversity reports). An obvious linkage exists between the diversity issues in high-tech

and the communities that are most vulnerable to gentrification: ethnicity and class. The average demographics of Bay Area communities most affected by gentrification (Blacks and Latinos) are similar to the least represented groups in the high-tech industry. The most concerning aspect of this linkage is in how it might imply ever-increasing challenges to the social mobility of lower class communities.

In thinking about the issues of mobility in the Silicon Valley, I referred to David Mosse's book, *Cultivating Development* (2005), which is about the anthropology of development, specifically the social and economic mobility of economically disadvantaged minorities. Mosse noted that by adopting customs of groups with greater welfare, including food, dress, and language, groups of Bhil people were able to foster connections with these groups and it ultimately led them to greater mobility and resources. Mosse's book suggested that the sharing of customs could act as points of connections between marginalized and privileged communities. Yet, in the Silicon Valley, learning high-tech skills required *technical* resources that individuals from economically disadvantaged might find challenging to acquire. Consider software engineering, which often requires powerful computers and subscription to Internet services. In addition, high-tech careers require advanced education, and students from elite universities appear to have a significant advantage. For instance, Google, StubHub, Instagram, PayPal, LinkedIn, and Snapchat, all have founders whom either attended Stanford as undergraduate or graduate students.

Learning the language, eating the food, and wearing the clothes of groups with greater access were most likely challenging practices to achieve for the Bhil people that Mosse (2005) studied. But I wondered whether the economic gap between the high-tech

sector of the Silicon Valley and its economically disadvantaged communities was becoming unprecedentedly wide. It is important to mention that prominent tech firms like Google, who initiated a community program to boost computer literacy and programming skills in economically challenged Bay Area communities called "Hack the Hood", have publicly demonstrated concern and action related to these issues. I understand that it is easy to oversimplify solutions to these problems and that I, as member of an economically disadvantaged community and ethically concerned anthropologist working in high-tech, have a responsibility to be mindful of my subsistence patterns related to these disparities. A poignant questions that I considered is: How might the disparity in the Silicon Valley might reflect issues that could manifest in other societies, including ones abroad, as a result of technological developments? How might design thinking and anthropology offer frameworks for generating possible solutions to these issues? What are the ways that technology can be used, or designed, to assist in the improvement of welfare and mobility of economically disadvantaged communities in the Bay Area now and in the future? And lastly, which jobs and economies have both been created and disrupted by high-tech enterprises and what imagined futures might we formulate based on these patterns?

Evidently, these questions do not have simple answers. Nevertheless, the pursuit of these questions and other questions the relationship between technology and economic disparities seem more relevant than ever. My training in applied anthropology has instilled within me a social awareness that has helped me to collaborate with others for creative action. The experience and knowledge that I gained in this project has led me to

a career in design research and with an interest in exploring the ways that the high-tech industry can serve as a tool for greater economic equality in human societies.

References

Aaker, D. A., Kumar, V., & Day, G. S. (2008). *Marketing research* (5th ed.). New York, NY: John Wiley & Sons.

Albert, W., & Tullis, T. (2013). *Measuring the user experience: Collecting, analyzing, and presenting usability metrics*. Waltham, MA: Elsevier, Inc.

Avery, M. L., English-Lueck, J., & Hamamoto, B. (2014). Farms to firms scenario memo: Creating better food futures. *Institute for the future memorandum,* 1-30.

Beebe, J. (2014) *Rapid qualitative inquiry: A field guide to team-based assessment* (2nd ed.). Lanham, MD: Rowman & Littlefield.

Bernard, H. R. (2011). *Research methods in anthropology: Qualitative and quantitative approaches*. Lanham, MD: Rowman Altamira.

Bruce, B., & Berg, M. (2001). Qualitative research methods for the social sciences.

Campbell, T., Williams, C., Ivanova, O., & Garrett, B. (2011). Could 3D printing change the world? *Technologies, potential, and implications of additive manufacturing.* Washington, DC: Atlantic Council.

Corey, M., Corey, G., & Corey, C. (2013). *Groups: Process and practice*. Cengage Learning.

Cutler, K. (2015, January 10). East of Palo Alto's Eden: Race and the formation of Silicon Valley. *TechCrunch.* Retrieved from http://techcrunch.com/2015/01/10/east-of-palo-altos-eden/

Diversity (2015). *Google.* Retrieved from https://www.google.com/diversity/

English-Lueck, J. A. (2002). *Cultures@ Silicon Valley*. Stanford, CA: Stanford University Press.

Glaser, B., & Strauss, A. (1967). *The discovery grounded theory: Strategies for qualitative inquiry*. Chicago, IL: Aldin,

Goodwin, C. J. (2009). *Research in psychology: Methods and design*. John Wiley & Sons.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods*, *18*(1), 59-82.

Hodder, I. (2012). *Entangled: An archaeology of the relationships between humans and things*.John Wiley & Sons.

Horowitz, B. (2010, March 2). How angel investing is different than venture capital. *Business Insider.* Retrieved from http://www.businessinsider.com/how-angel-investing-is-different-than-venture-capital-2010-3

Howell, D. (2013). *Fundamental statistics for the behavioral sciences.* Cengage Learning.

Hull, C. W. (1986). *U.S. Patent No. 4,575,330.* Washington, DC: U.S. Patent and Trademark Office.

Jacobs, P. F. (1995). *Stereolithography and other RP&M technologies: From rapid prototyping to rapid tooling.* Society of Manufacturing Engineers.

La Monica, P. R. (2014, May 11). Uber may now be worth $50 billion. Really? *CNN Money.* Retrieve, from http://money.cnn.com/2015/05/11/investing/uber-50-billion-valuation/

Latour, B. (2005). *Reassembling the social-an introduction to actor-network-theory.* Oxford University Press.

LeCompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of educational research*, *52*(1), 31-60.

LeCompte, M. D., & Schensul, J. J. (2010). *Designing and conducting ethnographic research* (Vol. 1). Rowman Altamira.

Lee, T. (2015, January 2). 2015 could be biggest year ever for tech IPOs. *SFGate.* Retrieved from http://www.sfgate.com/business/article/2015-could-be-biggest-year-ever-for-tech-IPOs-5988272.php

Little, P. (2013). Vapor Intrusion: The political ecology of an emerging environmental health concern. *Human Organization*, *72*(2), 121-131.

Ljungblad, S., & Holmquist, L. E. (2007, April). Transfer scenarios: Grounding innovation with marginal practices. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 737-746). ACM.

Mariampolski, H. (2006). *Ethnography for marketers: A guide to consumer immersion.``* Sage.

Marmer, M., Herrmann, B. L., Dogrultan, E., Berman, R., Eesley, C., & Blank, S. (2011). Startup genome report extra: Premature scaling. *Startup Genome*, 10.

Mason, M. (2010, August). Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qualitative Social Research* (Vol. 11, No. 3).

Meyers, C. (2015, May 13). Decoding Uber's proposed $50B valuation (and what it means for you). *Forbes.* Retrieved from http://www.forbes.com/sites/chrismyers/2015/05/13/decoding-ubers-50-billion-valuation-and-what-it-means-for-you/

Moore, Geoffrey A. *Crossing the chasm: Marketing and selling technology products to mainstream customers*. New York, NY: Crown Business, 2014. Print.

Mosse, D. (2005). *Cultivating development: An ethnography of aid policy and practice*. Pluto Press, London.

Newton, D. (2001, July 15). Understanding the financing stages. *Entrepreneur.* Retrieved from http://www.entrepreneur.com/article/42336

Nielsen, J. (1994). *Usability engineering*. Elsevier.

Ozbolat, I. T. (2015). Bioprinting scale-up tissue and organ constructs for transplantation. *Trends in biotechnology*. Elsevier.

Price, D. (1998). Gregory Bateson and the OSS: World War II and Bateson's assessment of applied anthropology. *Human Organization*, *57*(4), 379-384.

Projected size of the global market for 3D printing, materials & associated services in 2014 and 2018. (2014). *Statista.* Retrieved from http://www.statista.com/statistics/315363/global-market-for-3d-priting-and-services/

Ries, E. (2014). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. New York: Crown Business.

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: how to plan, design and conduct effective tests*. John Wiley & Sons.

Schensul, J. J., & LeCompte, M. D. (2012). *Essential ethnographic methods: A mixed methods approach* (Vol. 3). Rowman Altamira.

Sleeswijk Visser, F., Van der Lugt, R., & Stappers, P. J. (2007). Sharing user experiences in the product innovation process: Participatory design needs participatory communication. *Creativity and innovation management*, *16*(1), 35-45.

Somerville, H. (2014, August 11). VC quarterly report: Looking a lot like the last dot-com boom. *Business.* Retrieved from http://www.mercurynews.com/business/ci_26295669/siliconvalley-vc-investments-startups-resemble-dot-com

Textor, R. B. (1985). Anticipatory anthropology and the telemicroelectronic revolution: A preliminary report from Silicon Valley. *Anthropology & Education Quarterly*, *16*(1), 3-30.

U.S. Census Bureau. (2013). *State median family income by family size*. Retrieved from http://www.census.gov/hhes/www/income/statemedfaminc.html

Wasson, C. (2000). Ethnography in the field of design. *Human organization*,*59*(4), 377-388.

Appendix A

Consent Form (For Adult Participants) Agreement to Participate in Research Responsible Investigators(s): Armando Ayala

Title of Protocol: The Rise of the 3D Printer: An Ethnographic Analysis of Consumers' use of 3D Printers, 3D Printing Services, and 3D Printing Products in the Silicon Valley.

1. You have been asked to participate in a study to better understand the emerging 3D market in the San Francisco Bay Area, and the Silicon Valley. You will be asked questions about your use and knowledge of 3D printers, your preferences, your identity, and your predictions about how the 3D printing market will change over time.

2. The interviews will be recorded and transcribed to help the interviewers create more complete summaries. Quotations from your interview may be used to highlight points. Photographs may be taken of artifacts and scenes, but not of identifiable persons.

3. The risks posed are minimal, reflecting only what would be experienced in the normal course of life. A loss of privacy is often a risk in ethnographic interviewing. Confidentiality procedures protect against a loss of privacy.

4. The benefits come primarily to San Jose State University. However, this interview may give also you a new perspective about your use of emerging technology trends.

5. Although the results of this study may be published, no information that could identify you will be included. Pseudonyms, false names, will be used for you and all the people you mention.

6. There is no compensation for your participation.

7. Questions about this research may be addressed to Armando Ayala (209) 879-3271, armandoayala22@gmail.com. Complaints about the research may be presented to Dr. Charles Darrah, Chair, Anthropology Department, (408) 924-5314, Charles.Darrah@sisu.edu. Questions about a research subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2427.

Initial_____

8. No service of any kind, to which you are otherwise entitled, will be lost or jeopardized if you choose not to participate in the study.

9. Your consent is being given voluntarily. You may refuse to participate in the entire study or in any part of the study. You have the right to not answer questions you do not wish to answer. You will get a copy of the transcript and will have another opportunity to withdraw information at that time. If you decide to participate in the study, you are free to withdraw at any time without any negative effect on your relations with San Jose State University or any of its research partners in this project.

10. At the time that you sign this consent form, you will receive a copy of it for your records, signed and dated by the investigator.

The signature of a subject on this document indicates agreement to participate in the study.

The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.

_____ _____

Participant's Signature Date

_____ _____

Investigator's Signature Date

Appendix B

3D Printing and Human Networks [Developed by Armando Ayala)

Purpose The goals of this project and interview are to:

1. Examine individual's experiences with using 3D printing technology and services and explore what this technology means to them. Probe individuals' likes and dislikes of 3D printing technology and services.2. Examine the networks that have led or supported individuals to utilize or purchase 3D printing technology. The sub-questions within this domain will briefly explore economic, psychological, cultural, and regional facets of individuals that may have made them more inclined to become consumers of 3D printing technology.

4. Inspect individual's beliefs and attitudes about how 3D printing technology will change and develop in the future.

Place. The interviewee's preferred meeting area (e.g., Library, Home, Meeting room at their place of work)

Population characteristics: Consumers and non-consumers of 3D printing technology, including products and services.

Materials

1. Instrument, pens and notebook □

2. Two digital recorders, and spare batteries; □

3. Camera or digital camera capable of taking focused shots of material culture □

4. Two copies of the consent form □

Interview prologue:

[Introduce yourself and the project] "This is a project to learn about how people are thinking about, using, and buying 3D printers. 3D printers have become a significant and impactful technology within the last two years. This interview will ask you about the ways you have used, or have wanted to use 3D printers. This interview will also ask you questions regarding your personality and tastes in relation to 3D printers. We seek to understand the challenges and benefits to using 3D printers. And lastly, you will be asked about your thoughts about the future of 3D printers and 3D printing technology."

[Informed consent] Go over the informed consent with the participant. Seek permission to record their responses and permission to photograph settings and objects related to their 3D printing experience. All photographs will be free of images that may identify the interviewee. Let the interviewee know that their interview will be transcribed, and that some of their statements might be published. The interviewee may receive a copy of the transcript and ask any questions by contacting Armando Ayala at **email:** armandoayala22@gmail.com and **phone** (209) 879-3271.

Part 1. These questions will ask about your first experiences using and/or purchasing 3D printing technology, and about the things that prompted you to do so.

I am going to ask you some questions about your experience with 3D printing Please draw me a 3D shape.

1. Tell me about the first time you used a 3D printer? (If haven't, ask about the first time he/she heard about 3D printers, ask prompts that apply)

Probe: Who/What was it that prompted you to use it/introduced you/ told you? Probe: Where did you use it?□Probe: Why did you decide to use it?□Probe: What were your impressions about this technology before and after using? Probe: What did you make/build?

Probe: What materials were used?□Probe: Do you remember the brand of the printer?□Probe: Did you find it difficult or easy to use the 3D printer? Probe: What was the end result?□Probe: Did you have to pay? If so, how much?□Probe: Did you feel it was worth what you paid for?

2. Did you operate the software? (If so- ask the following questions) Probe: What software was used?□Probe: Was it difficult to use?□Probe: Did you learn new things while using the software? □

3. Have you used 3D printers since then?□Probe: Did the experience make you want one/use one again?□Probe: Did you feel satisfied with the quality of the item?□Probe: If you've used one multiple times, what do you think was the most useful item you've ever made? □

4. Do you see yourself using 3D printers in the future, and for what things? (Ask Probes if they apply) □Probe: At work?□Probe: At School?□Probe: If you were to invite others, or have invited others to use/buy 3D printers, what do/did you say to them? □

5. Have you purchased a 3D printer? (Ask prompts if answer is yes) Probe: What prompted you to buy it?□Probe: What brand is it?□Probe: Where did you buy it? □Probe: How much did it cost?□Probe: Do you feel it is worth what you paid for? □

6. Have you heard of or used any 3D printing websites like Shapeways or i.Materialise? □Probe: Who/What was it that prompted you to use it/introduced you/ told you? Probe: Where did you use it?□Probe: Why were you there to use it?□Probe: What were your impressions about this technology before and after using? Probe: What did you make/build? □Probe: What materials were used?□Probe: Did you find it difficult or easy to use these Internet services? Probe: What was the end result?□Probe: How much did you have to pay for the service and product? Probe: Do you feel it was worth what you paid for? □

7. Please think about the media sources you use to learn new information or to stay informed on current events. □Probe: Are there any T.V. channels or T.V. shows that you watch often? Probe: Standard, Internet, or satellite radio stations?□Probe: What websites do you use? Please include social networking apps/sites. Probe: What sources do you use to find information that is reliable? □Probe: Have any of these sources provided information on 3DPrinters? □

Part 2 Personality, Context, and Culture

8. I am going to ask you a few background questions about your life and about what you do for a living. First, if you work, what sort of work do you do? Where do you do it? If you go to school, where do you go to school? What do you study?

Probe: How long have you been doing this type of work or have been at this worksite?□Probe: Please describe a typical weekday/workday.□Probe: Considering your financial status, did you find your 3D printing experience /3D printer to be affordable?

9. The following questions will be demographic in nature. Can you please describe the ethnicity/ethnic heritage that you identify with?

Probe: Age?□Probe: Where do you live?□Probe: How long have you lived near/in the Silicon Valley?□Probe: Where did you live before, if you are not native to the area?□Probe: Would you describe yourself and/or your immediate family as lower class, middle class, upper-middle class, or upper class?

10. Are you a part of any organizations, like a gym, club, or religious organization? Probe: What do you do at these organizations?□Probe: When do you go to these organizations?□Probe: Have you learned about technology from them?

11. Tell me about the brands and types of technology products you use, if you do not own the products discussed please say so.

Probe: Smartphone? Probe: Tablet?□Probe: Wearable?□Probe: Laptop computer? Probe: Desktop?

Probe: Gaming console(s)?□Probe: Car?□Probe: 3D Printer?□Probe: Any other technology products you use often?

Part 3: Likes and Dislikes

12. These questions are about your preferences regarding the use of 3D printers that are typically used in person, (at home, work, etc.)□What do you like about using 3D Printers? (Ask probes that apply)□Probe: Do you find the materials for 3D printers to be affordable? □Probe: Do you find the technology to be convenient? Probe: Do you find the technology to be easy to use? Probe: Do you find the maintenance to be manageable? □

13. What are your current dissatisfactions with using 3D printers? Probe: The cost of materials. □Probe: The time it takes to print. Probe: Navigating the software Probe: Navigating the hardware □

14. These questions are about your preferences regarding 3D printing services like Shapeways and iMaterialize. (Skip if person hasn't used) What do you like about 3D printing services like Shapeways or iMaterialize?□Probe: Do you find services like Shapeways to be more practical than purchasing one's own 3D or using a local 3D printer? Please explain your reasons. □Probe: Do you find these services to be convenient?□Probe: Do you find these services to be easy to use?□Probe: Are the products you have made on these services affordable?□Probe: Do you prefer to design your own products, or do you prefer to download pre-existing files?□Probe: Do you find the time it takes to print and receive your finished product convenient/ reasonable? □

15. Are there things you wish you could print that you currently cannot? Probe: Size? □Probe: Complexity? Probe: Speed? □

Part 4 Future Developments

16. Do you see 3D printing technology developing and becoming more widely used in the future, if so how? □Probe: In home? Probe: In industry? Probe: In medicine? Probe: In media? □

17. Are there any technology breakthroughs you see emerging with regards to making or building things? □

18. If you could imagine the ideal 3D printing technology, what would it look like? Probe: What would be needed to help make that happen? □

Appendix C

[redacted]

Date: 02.20.2015

Dr. Roberto Gonzalez
Professor & Graduate Coordinator
San José State University
One Washington Square
San José CA, 95192

Dear Dr. Gonzalez:

Armando Ayala has provided the [redacted] team and I with a professional report about the current 3D printing consumer base in the Silicon Valley. His report contains insights that are important to our business intelligence. Furthermore, his report contains a series of marketing strategies that are being considered for implementation. He and I had an hour and half meeting to discuss the general findings of his report, the strategies that he designed, and futur[redacted] projects. Although I cannot explicitly state the specifics about how we intend to implement his strategies or how we will use the findings of his report, I can say that his work is invaluable to Trnio's development.

Sincerely,

[redacted]
CEO, [redacted]

Appendix D

Client Acquisition Memorandum

An Analysis of 3D Printing Consumers and their Networks in the Silicon Valley

Table of Contents:

Introduction

The 3D printing market is currently at 3.9 billion U.S. dollars and is expected to triple to about 16.2 billion U.S. dollars by 2018 (Statista.com, 2015). Since Trnio's products and proposed business model have demonstrated significant potential in this market, the company has recently pivoted its services towards 3D printing. This memo is meant to provide a basis for Trnio's future marketing strategies.

During a [redacted] meeting about potentially entering the 3D printing market, many questions about the current 3D printing consumer were raised, including questions about their interests, their process of introduction into 3D printing, and questions about how to expand the [redacted] consumer base. It was evident that very little was known about this emerging market and about it's prospective consumer. When little is known about a market, exploratory methodologies often provide excellent starting points. This memo was designed using an explorative methodology known as *rapid ethnography.* The data were taken from 14 individuals that fit at least one of three user types: (1) *Online 3D Printing Users*; (2) *Consumer-line 3D Printing Users*; and (3) *Non-Users.* Interviews were the basis of data collection, as well as visual observations of participants' daily life. All participants lived near (50 mile radius) or in the Silicon Valley (SV) and were all over the age of 18 during the data collection process. All names of informants, or of their places of work, consist of pseudonyms to protect participants' identity.

How to make best use of this memo

This memo provides two types of information that serve two specific purposes. The first type of information, covered in **Part A**, is about current consumers and their networks. These data are meant to provide *general information* about the consumer, which can help spur new projects and inform decision-making processes. The second kind of information, discussed in **Part B**, consists of *actionable strategies* for successful market entry.

Acknowledgments

Author: Armando Ayala

Special acknowledgments to: Dr. Roberto Gonzalez and Dr. Darrah for providing support and advising, to Dr. Jan English Lueck for providing a report framework, to The SVF Forum, and to all those designers, builders, 3D printer users, and potential users who provided us with their invaluable time and stories.

A1. Consumer Networks

The networks studied in this report consist of intersections between consumers and their environments that were related to 3D printing. This segment is meant to produce an understanding of how individuals are coming into contact with 3D printing and how they invite others to use 3D printing technology.

Points of Introduction After compiling much of the data, the results suggested that most participants became introduced to 3D printing at their jobs, either by using a 3D printer at work, or by their line of work being related to 3D printing and design. These findings suggest that work, as either a place or a career type, was important for how participants were introduced to and adopted 3D printing. Perhaps the way work facilitated tactile, in-person experiences with 3D printing acted as a factor in its adoption. At a Shapeways.com party that I attended in San Francisco, almost all of the eight participants had worked in some form of design industry. Sarah, who hosted the event, once worked for a jeweler for whom she printed 3D wax jewelry models. She stated that 3D printing was a natural advancement in her interests. Sarah is now an artist who sells her 3D printed jewelry and other items on Shapeways.com

Matías and his father David were the only two individuals who explicitly stated that they first used a 3D printer without any direct relation to their occupations; they went to the San José Tech Museum to take a 3D printing class together and described it as "bonding time."

"At my work, we were 3D printing some parts and I was asked to help with that process... We were printing inserts for syringes that our app would scan to measure the blood content...**that was the first time I ever used a 3D printer**" – Samuel, a recent college grad working at a SV start-up, was introduced to 3D printing at work.

"**Having seen them at work, I wanted one for personal use**... I got the idea from my boss (who purchased a Chinese imitation of the MakerBot they have at work)." -Colton, who works as a mechanical engineer, purchased the same 3D printer as his boss.

3D Printing and the Media I assumed the findings would demonstrate direct links between media coverage about 3D printing and 3D printing consumption, but the findings did not support my assumptions. Most people had first heard of 3D printers when the story broke about a man who was able to successfully 3D print a firearm. This story did not inspire any of the participants to use 3D printing. Also, none of the participants stated that they had decided to try 3D printing because of a particular advertisement or news segment. Some people did say that they read about 3D printers on technology blogs like TechCrunch and Gizmodo, but what they read on these sites was not enough to persuade them to use 3D printing. Nevertheless, the workplace emerged to be the most significant facilitator of individuals' first interactions with 3D printers. These findings do not necessarily suggest that the media doesn't adequately cover 3D printing stories and developments, or that advertisements are ineffective in expanding the 3D printing consumer base. What this data does suggest is that in-person experiences might be effective in in expanding the 3D printing consumer base. More about the in-person experience will be discussed in section B of the memo.

Demographics During the initial meeting, questions about the types of people who were using this technology were brought up. We wondered whether there were any significant patterns of ethnicity, work, education level, or age present in the 3D printing market. It's important to keep in mind the limits of a rapid ethnography; this style of research is context-specific, meaning that it's not recommended to make generalizations about ethnographic research findings to the general public. Nevertheless, this research did leave me with material that led me to speculate about what average 3D printing consumer demographics might be like.

One speculation is that 3D printing is not bound to any ethnic groupings. The people that were interviewed represented as much diversity that one may experience in everyday life in the SV. There were an equal number of informants from Asian, European, and Latin American descent. Although I did not have any participants of African decent, the findings did not imply that there were any significant ethnic barriers to becoming a consumer of this market.

There is a common conception that "young people" (ages 13-25) are the ones who tend to adopt technology at a faster rate than other age groupings. Although this might be true for some technologies, like social media, 3D printing informants consisted of a diverse range of ages. The youngest was 18 years old and the oldest was over the age of 60 years. The mean age of people in this study was about 34 years old. Even though the study did not consist of 3D printing informants under the age of 18, the data from this study led me to speculate that the current market might have a high number of young and middle-aged adult users. There is a high level of technical complexity and high cost that coincides with 3D printing. In other words, I speculate that adults might be more likely than younger people to consume 3D printing products and services because of their higher income levels and because of their refined technical skills and knowledge.

In relation to costs associated with 3D printing, work and education levels did seem to be extremely similar across many participants. All but one of the participants were either studying for a Bachelor's degree, or had completed one. The person with the highest level of educational attainment, David, had a PhD in physics and worked as a technician for a biology lab at a university in the SV. As mentioned earlier, many of these participants were introduced to 3D printing at work, suggesting that 3D printers, and their use, are common in well-paying jobs, especially in tech companies. Furthermore, tech companies appear to be more likely to have needs for 3D printing, especially tech startups that require cheap methods of rapid prototyping. These patterns are very reflective of the SV, which is known for its tech-centered and highly educated workforce.

These speculations can serve as a starting point for further research, especially a quantitative demographic analyses that can be used to make robust assumptions about this market and its average public consumer. Section B of this memo contains a section about Trnio's assumed primary and secondary target consumers, which were designed using these findings.

A Community of Experienced and New Users There were two main events that I attended which helped me understand how users form communities: (1) The Silicon Valley Forum (SVF) in Santa Clara, which consisted of people from various facets of the 3D printing industry, and The Shapeways.com party that I attended in San Francisco. Both of these meetings utilized MeetUp.com as networking tool. Almost all informants utilized social media technology to connect with other users and non-users.

Sarah, who organized and the led the Shapeways.com party, did so for both personal and business reasons. For instance, creating the MeetUp provided her with a better connection to other users in her local community. Although one might assume that promoting Shapeways.com was the main intent of the party, the attendees exuded a sense of pure enjoyment more akin to a hobby-based group instead of one made up of sellers and entrepreneurs. The users at the Shapeways.com party were all extremely comfortable with complex CAD modeling software, especially SolidWorks. Because of this, one could conclude that users have driven Shapeways.com to represent a highly skilled community of users, something that may not appeal to new users who are intimidated by technology like SolidWorks. Section B of this memo will discuss how these findings relate to the marketing of Trnio.

Furthermore, The MeetUp provided each designer with an ability to discuss different aspects of the Shapeways.com process. In a world dominated by online social networks, it's interesting to note that Shapeways.com users were eager to interact with each other in person instead of just communicating over the site's forums. This stirred up questions about the role of embodiment and tactile experiences in 3D printing, which should be considered in further research. The physicality of their experiences were important to the users; many brought in models so that the other attendees could experience them in person and compare them to see the different variations of accuracy, firmness, smoothness, and size. As stated previously, the findings suggesting that in-person experiences might be potent for expanding the 3D printing consumer base.

A2. Consumer Impressions About 3D Printing

Many of us at [redacted] wanted to know more about the factors of 3D printing that drew new consumers and about factors that continually satisfy current 3D printing users. In other words, why do people like 3D printing and what do they like most about it? This included questions about consumer preferences for quality, complexity, production speed, affordability, and usability. This section contains information about these topics and many of the actionable strategies included at the end of this memo were born from the findings in this section.

Quality [redacted] potential as a significant competitor in the 3D Printing market has been assessed as highly probable. However, Trnio's scanning process does not always render picture-perfect models, which has led to ideas about designing software that can automatically complete or modulate scans to make them ready to print. Therefore, the issue of quality presents itself as a burning question. For instance, what is the degree of quality that potential [redacted] users would want with regards to their 3D prints? One thing from the research became clear: all user informants saw high quality of 3D prints as extremely important. Informants commonly defined quality by durability, aesthetics, size, sharpness, accuracy, and complexity. These conclusions could perhaps direct further research and development regarding the design and execution of Trnio's 3D printing services.

"Some of the things I would want to print are things like the structure of a protein molecule...**I would like to print it at high spatial resolution...each atom having a different color...[and make] the external layers of atoms transparent**...I don't know of any printer that could do that right now....**If I were to order something [online], I would want it to be of a higher quality than what you get with a standard [home] 3D printer**"– David, a physicist and engineer at a university biology lab.

Shapeways.com party observation: All attendees discussed **high accuracy as extremely desirable.** One man used Shapeways to make realistic miniature objects for his model trains and asked other users about how to improve the sharpness and complexity of his 3D prints. The iPhone cases, shown on page eight, required a high degree of accuracy, and the designer found it frustrating when her 3D prints resulted in a need for further iterations because of poor design or poor printing processes. **Also, the Shapeways.com users said that they preferred Shapeways because the models were well designed and found the free models available on websites like Thingiverse.com and ScrapCAD.com to be low-grade and low quality.**

Functionality The [redacted] team also had questions regarding the common intended purposes of objects that were made with 3D printing. One question asked was whether 3D printing consumers were more likely to print novelty objects (e.g., toys, decorations) over functional objects (smartphone cases, door handles, hinges). In rapid ethnography, it is best practice to allow informants to define their reality and relate this to the observer, rather then the other way around. Therefore, many of the information in this section demonstrates the manner in which informants defined a "functional product" and contains insights as to what sorts of things people are currently printing. When participants spoke of functionality, it often coincided with speed. For instance, one participant stated that 3D printers were useful because they provided consumers with unique parts that would have taken much longer to make with other manufacturing processes. Another important finding is that many who viewed 3D printers as a utility tended to express ideas that suggested a sense of empowerment. The ability to build something empowered them.

"My goal was to be able to produce my own parts and design my own prototypes...**I worked on a bicycle project, and I designed and built the full-scale bicycle frame**... As an industrial designer, there's a real advantage in being able to produce something right away instead of having to wait, **because other than 3D printing, somebody has to do it, either by hand or by standard manufacturing...[3D Printing] It's something fast...that's why it's called rapid prototyping."** -Hector describes his enthusiasm about his ability to print a full-scale bicycle frame. **Notice the tone of empowerment in his use of language**.

For some individuals novelty and fun served as a functionality of 3D printing in and of itself:

Colton said that his 3D printer serves many functions for him and his family: "I'm into model rocketry...me and my son fly model rockets together... We have models that we build, they [the rockets] have stages... **Now if those parts break, it's almost disposable because we can print a new part for it**...My wife uses the printer to make cookie cutters and she then sells them..."

Functionality Continued

Perceived lack of functionality might be a significant resistance point for people who don't use 3D printing. Justin, a recent college grad, said that he doesn't see a personal need for 3D printers because the products he would want to make will probably be available at a store, either online or in a storefront. Samuel, another recent college grad said that although he sees the functionality of 3D printers, he is yet to find a personal need for them.

"I know of a friend mine's brother has a 3D printer and he uses it to make little nifty gadgets...Like he made an adaptor for his brother so that he could fit his favorite Nalgene water bottle, which is pretty wide, into his car's cup holder. **So for things like that it would be very useful. I myself am just not that interested in making unique kinds of things like that**. It's just not something that appeals to me." –Samuel.

Many of the Shapeways.com users had similarly defined functionality: they also framed personal enjoyment as a utility of 3D printing. Nevertheless, some of their items could be regarded as "functional", like the Square Reader case below. And like most everyday products, aesthetics was often incorporated into many models, regardless of intended purpose. Business was another functionality of using Shapeways.com as three individuals used the site to operate an online store. But Lucia, who designed the seahorse pictured below, stated, "I don't sell any items on Shapeways. I make these items for myself and for friends." Perhaps statements like these illustrate the variety of uses that 3D printing serves for consumers.

Below: User-made objects from the Shapeways.com party

From left to right: iPhone 6 Case; Square Reader case; Metal Seahorse with gold color (pearl necklace is store bought); and miscellaneous items including jewelry and a metal bottle opener.

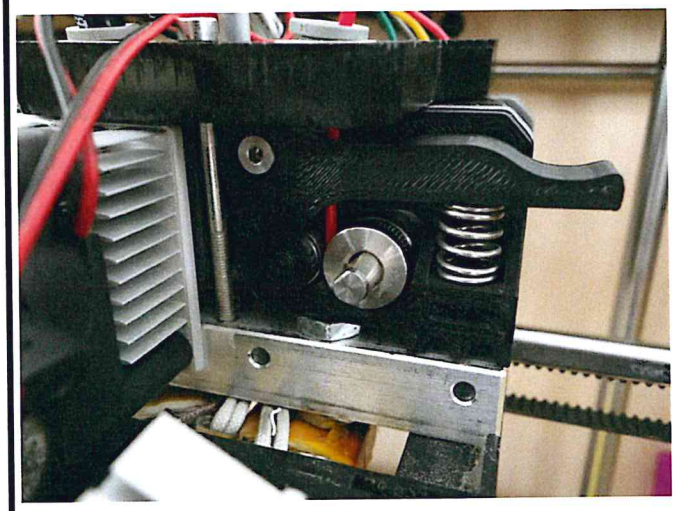
Usability Since [redacted] intends to provide services that could potentially make aspects of 3D printing much easier, the topic of usability presented itself as an important topic of investigation. Trnio will benefit from this information because understanding these obstacles can direct product development strategies. For most users, the greatest obstacles to using a 3D printer were found in the process of designing models, not the act of printing itself. Many designers used SolidWorks as the main design platform, but did not like having to pay for the expensive SolidWorks license, nor did they like the steep learning curve that came with it. Many users spoke of technical skills and how these were required if one wanted to fully take advantage of 3D printing. Another obstacle, although much less discussed, was maintaining a home 3D printer.

Shapeways.com users stated that the printing turnaround time often made iterative processes inconvenient. For instance, if a designer is looking to immediately sell their piece on Shapeways.com, they can only do so when they feel they have reached peak quality. Participants expressed that reaching peak quality will often take anywhere from two to ten iterations. Also, users complained that it could take up to three weeks for a new iteration to arrive, which must be assessed for quality. Iterations are also expensive as the designer must purchase each iteration. If framed as a personal business venture, the Shapeways.com business model can manifest significant overhead costs for sellers. Therefore speed is a domain that also impacts how users perceive the usability of 3D printing technology and services.

"I mean I don't think I would want to use it personally just because I don't have an interest in inventing new products...And also I don't have an interest in using it **because it seems like the process of making the design is really technical and complex and I just don't have the skills to do that. It's not the printing, the printing is really simple, but it's everything that comes before that, that is the complicated part**." –Samuel.

"I find SolidWorks to be the best, I honestly haven't used anything else other than SolidWorks, but just based on how customers describe other software programs...they just seem to have so much trouble with them [other programs]...**Once you get the hang of the program, you can navigate it fairly quickly. Of course the more complex the shape is the more difficult it's going to be. If you start having surfaces that turn, bend, and twist, then it's going to make much longer to design.** However, if you are just making something as simple as a cup, it can be as easy as making a circle and extruding it [in SolidWorks] and there you have your cup." –Hector on SolidWorks

Usability Continued



Above: Photograph of a typical MakerBot extruder. For many people, maintenance may be perceived as difficult.

"We've had it since last February (almost a year since interview) and I've only had one problem with it and it involved getting a piece of plastic stuck in the feeder (i.e. extruder). **I had to take the head apart and put it back to together again...probably not a fair comparison because I'm an engineer...when you look at something like that it's not hard.**" -Colton on the maintenance of his dual extruder MakerBot replica.

Another usability issue that some participants spoke of was how to deal with the heating bed, which not all printers have. Certain temperatures work better with different plastic materials. Some models also require stints to support the object while they are being printed. These stints are built to be removed, but can present another technical challenge for new users. All of these issues are important for [redacted] to consider when designing services that might be used by home 3D printing consumers. It is also necessary to contemplate the marketability of home 3D printing versus online 3D printing. These findings suggest that online printing might be the most effective selling channel for new users because it removes many usability barriers.

Affordability Knowledge about consumers' perceptions about cost is essential to implementing an effective business plan and marketing strategy. 3D printing is unique in that its market exists between extreme disparities in price points of service, technology, and materials. There seem be three loosely identified groupings of printing costs: (1) basic home 3D printing, which is relatively cheap (average printer cost range: 1,600$-4,000$); (2) online printing, which is pricier but affordable (printer cost is zero and the price range for models is anywhere from 30$ to 600$); and (3) high-end printing, which is out of reach to the everyday consumer (average printer cost range: 20,000$- 500,00$). Most people did not think of 3D printing as an affordable venture even when they considered the lower end models. Many of the non-users often overestimated the cost of materials. One said that ABS plastic was about 10 dollars per cubic inch, but it's usually lower than 10 cents per cubic inch. This suggests that non-users assume 3D printing to be expensive. All these facets are significant for identifying key resistance points.

Shapeways.com users seemed largely satisfied with the pricing of the website even though the service presented significant overhead costs to their online selling ventures. Nevertheless, the informants stated that they felt that pricing was fair and that their ability to mark up the price created sufficient revenue.

When asked about whether he found 3D printing to be affordable, Matías, an 18 year old computer programming student stated: **"I don't find it to be affordable."**

I asked him what he would be wiling to pay for a six-inch figure from an online 3D printer, he stated: **"I'd say depending on the part, and it also depends on the size of the thing. If I were to make something six inches tall, six inches wide, and six inches long [then I would pay] maybe 20 bucks total. For a larger piece, maybe thirty to thirty-five dollars total."**

There seems like there's a pretty big barrier in terms of becoming a user of a 3D printer because of the skills required to create designs and because the costs of the equipment itself. **Because of what I understand, even the really inexpensive [printers], the one [printer] we had at work still cost 1,600 dollars...just to have that income..."** –Samuel on the high price of 3D printers.

"I mean to be honest, the material [cost] is almost a non-issue because you can get like two kilograms of PLA or ABS [plastic] for like 20-25 dollars...A single cookie cutter probably weighs an ounce...**you've got almost five pounds of material per spool so you do the math. It's a lot of cookie cutters.**" –Colton on the low price of home 3D printing materials.

A3. Consumer Speculations About 3D Printing

Technology and innovation create rapid changes in culture. Because of the tech-centered nature of the SV, I incorporated a future-based set of questions in my interviews and asked participants about their imagined futures about the ways in which 3D printing might develop and how it might change their local culture. It's safe to assume that questions about one's imagined future often reflect aspects of one's present and one's past. Questions about the future might also generate different insights because it directs people to think in a different manner, which might cause them to make connections that they weren't able to make in a present-based frame of thinking. Another possibility is that consumers might be good predictors about how a market will grow and change, leaving this report with good hunches or leads. Therefore, this section consists of findings related to this topic, which connect with many of the previously explored topics like functionality, usability, and accessibility.

Potential Uses for Currently Existing Technology Some of the Shapeways.com users offered reasons as to how 3D printing could impact society for the better. The conversations started with one designer telling me about a man who was able to 3D print his son a prosthetic arm for about 200 dollars. They mentioned that this was something that could potentially reach more people in need of this service who reside in lower levels of income and potentially help people with the same need in low-development countries. Another designer stated that 3D printers could have significant potential for blind persons and their families who could use 3D printers to easily print plastic brail pieces. The same designer stated that 3D printers held potential in the classroom because it could allow instructors to print small replicas of historic buildings or artworks in a cheap manner. Three-dimensional models could create a new level of interaction for students. Blind students who have never had the opportunity to cheaply access historic replicas could also utilize these models to experience a touch-based encounter.

"I mean, yeah, I can see them [3D printers] making a difference. I can see them potentially be a very different business model that's possible with 3D printing. Like what we were talking about earlier with the creation of products as they are demanded in a live fashion. **If that were developed more thoroughly and gained larger prominence in society than that can have a really positive effect for reducing environmental impact...definitely reducing overstock by a lot.** And I can see the potential of a culture where people are creating their own designs and sharing them amongst each other and making different things" – Samuel on the positive impact of "live-demand" consumption.

Potential Developments in 3D Printing I asked informants to think beyond the current available options in 3D printing in order to imagine how 3D printing might develop in the future. They commented on potential changes within business, medicine, and manufacturing.

"I think, or hope, that it will be used for high-volume 3D printing, which is being able to mass-produce products. Right now it's more for low volume because it takes time to print parts... It would really excite me to have one, but for it to be the next washer and dryer, there will still be a lot to be thought of. **Right now I don't see it as the next washer and dryer because it's already out there, because not everyone is into designing or building. I don't think it will ever reach that point because I don't see a real use for it. Everything is so accessible at this time, with the click of the button. Why go through the hassle of designing stuff. Most people will likely buy [pre-made] stuff online**." – Hector on the future of 3D printing. Hector thinks that 3D printing will have a greater influence in manufacturing than in home and personal use.

"I don't know...what I envision is that, you come up with an idea, you somehow verbally explain what you want to the printer, and with little design, or work, out comes a product that is close enough and high enough in quality to what you wanted."– David on the possibly intuitive and automatic processes of 3D printing.

In sum, 3D printers represent an incredibly disruptive model of consumption. It empowers consumers to build their own items based on their own needs. This disrupts many traditions of product branding. The Internet is a powerful component in this disruption in that it allows one to create new niche audiences who share narrow interests. For example, the Internet fosters the ability to create groups for hobbyists (e.g., model rocketry) and these new audiences will drive a new type of consumption with regards to 3D printing, one that could potentially sustain itself on niche markets. In the past, niche markets may not have had the platform to build potential market share, therefore limiting their establishment, but 3D printing is flexible and can sustain various products that can be sold to limitless niche markets. In this regard, quantity and quality become redefined, as well as supply and demand.

B1. Market Position and Strategy

[redacted] **Position Within the Market** The most breakthrough insight that has emerged from the data is the potential for [redacted] to fill a new need, one that is both innovative and disruptive. Shapeways.com is dominated by highly skilled and highly creative consumers, which has shaped its branding. This representation of the average Shapeways.com user as a "designer" might deter potential new users who are not necessarily interested in becoming highly skilled designers, but could otherwise benefit from 3D printing services and products. [redacted] represents a service that sells extreme usability as its major marketing strength: anyone who has a smartphone can produce a highly detailed 3D model with [redacted] and can also print it out. Therefore, the usability of the app should inform its position within the market. [redacted]

"It [3D Printing] seems like it requires of lot technical savvy for you to be able to benefit from it. **So maybe if 3D printers were designed in a way that people, like my dad who just got his first iPhone and has been using a non-smart phone, would be able to easily use and understand them. I can see that increasing the likelihood of me to use one**" – Samuel.

[redacted] also has potential in software marketing. Online 3D printers often run off of two main components: CAD software (e.g. SolidWorks) and suppliers (e.g. Shapeways/Sculptio). Trnio is disruptive in that it functions as the CAD software and the supplier in one. Although the software is currently limited to only a smartphone-based 3D scanner, the potential for Trnio becoming the most usable and most used CAD software is huge. [redacted] has the potential to make the first wave of users comfortable with scanning and printing. [redacted]

"You need to be able to design something without a 1,500 dollar SolidWorks license...If you work in the industry, there are very expensive CAD packages like SolidWorks. **There has to be something you know—maybe not as complicated—maybe not have all the features but something where you can design it in a 3D space relatively cheaply.**" – Colton on the need for cheaper and more usable modeling software.

This infographic illustrates Trnio's disruptive and transformative market potential.

INFOGRAPHIC HAS BEEN REDACTED TO PROTECT CLIENT PRIVACY

The four main advantages of [redacted] business model are:

1. Knowledge Sharing

[redacted]

How to make it happen

[redacted]

2. Transformation

[redacted]

How to make it happen

[redacted]

3. Brand Expansion

[redacted]

How to make it happen

[redacted]

4. Optimized Utility

[redacted]

How to make it happen

[redacted]

Target Consumer Based on the demographic analysis, we can make some assumptions about [redacted] target consumer. The demographic analysis was not a robust analysis; a larger sample would be needed to reach more confident assumptions. This study is also not able to produce an adequate market segmentation analysis. Nevertheless, the demographic findings can provide leads on what [redacted] primary B2C target consumer might be like.

Primary target consumer:

- Age 18 years and up
- Smartphone owner
- From lower to upper-middle class
- Creative
- Not a 3D designer
- Interested in new technology
- Pragmatic in spending
- Uses social media
- Values high quality
- Values aesthetic brands (i.e. Apple, Google)
- Conscientious of environmental impacts

Secondary target consumer:

- 21 years and up
- Technically inclined
- 3D designers
- Do-it-your-self enthusiasts
- Early adopters of new technology
- Engineering background or job
- Highly educated
- Prefers quality over brand-name
- Attend events like Maker Fairs or 3D printing MeetUps
- Use websites like Shapeways or Sculptio

Four Gears Model Geoffrey Moore's recent edition of *Crossing the Chasm* (2014) includes a model designed to guide the marketing strategies of digital-based start-up companies. This model is called the Four Gears Model and it states that online adoption consists of four main characteristics, which are not linear from one to four. Also, the Four Gears Model declares that all four gears (i.e. characteristics) must be in continual progress or else the entire enterprise will begin to encounter significant problems. The model is explained below:

1. **Acquire traffic**:
   This process happens simultaneously with engagement. Acquiring traffic has two components: (1) onboarding new users who will eventually want new features and updates, and (2) producing new content and/or product features.

2. **Engage users:**
   This one comes first and is the process of creating a compelling digitally mediated experience that keeps users coming back for more.

3. **Monetize their engagement:**
   This one is very self-explanatory, but should be done carefully with regards to the business model and online features. Also, many digitally mediated companies run on a model that focuses on acquiring a mass amount of users first and generating revenue later.

4. **Enlist the faithful:**
   This process can be understood as an evolved form of customer loyalty. Digitally mediated companies become successful because key customers develop an identity with the brand and are willing to evangelize the product to people in their network. This gear is based on the phenomenon of viral marketing and rapid consumer base expansions.

How This Model Relates to [redacted] Although an in-depth exploration into this model for strategy formulation is beyond the scope of this memo, it is important to consider the emerging market that [redacted] business model represents. [redacted] has demonstrated viability for B2B marketing, such as e-commerce, but has also produced a digitally mediated product that requires B2C marketing. It is becoming harder and harder for tech start-ups to separate B2B from B2C because both seem to be converging. These concepts are foundational to the [redacted] success and should be addressed in future meetings or projects.

B2. Object-Based Marketing Campaign

Embodiment

[redacted]

1. Promotional in-person product placement

[redacted]

2. Print and scan booths

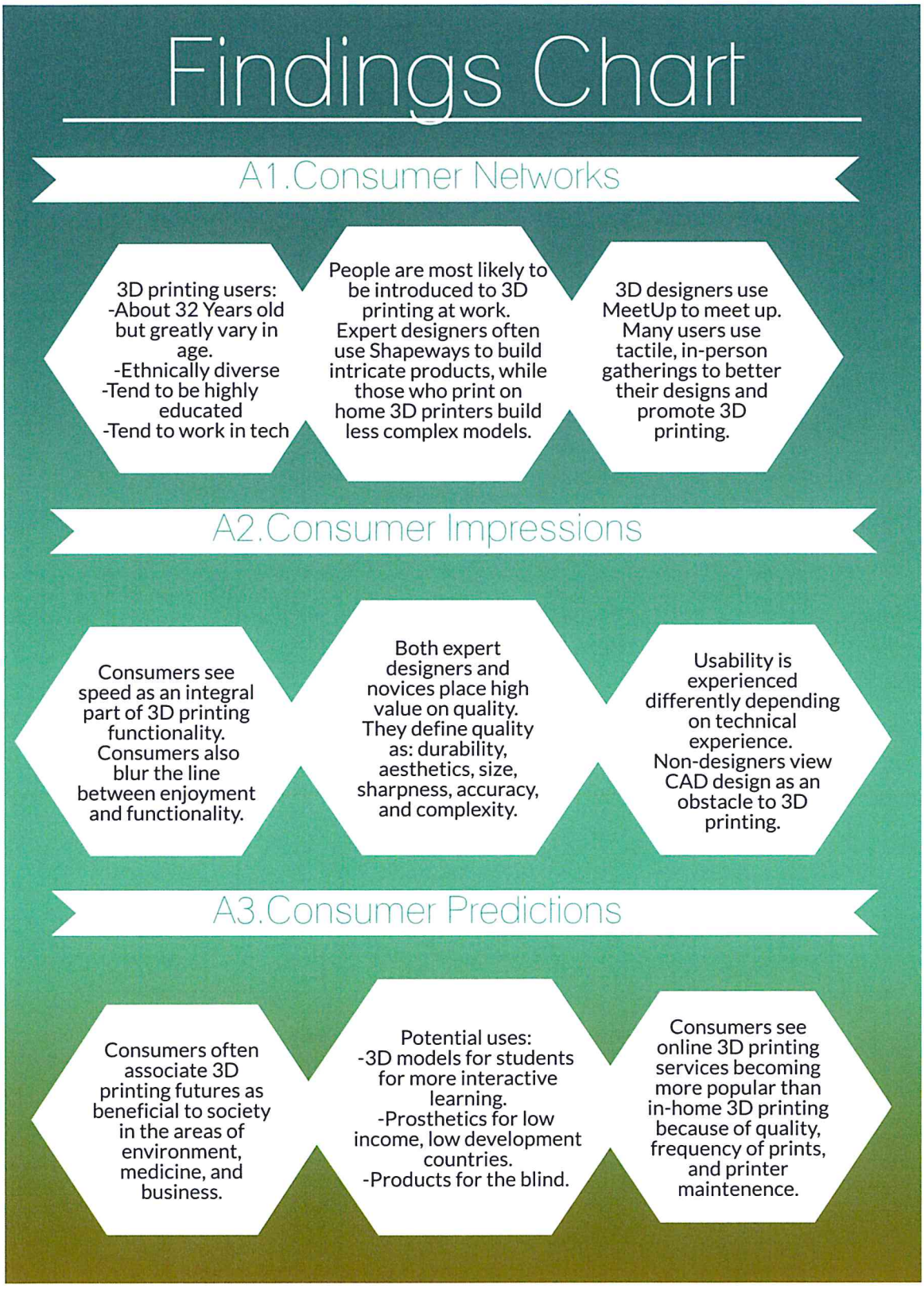
[redacted]

3. Kickstarter, crowdsourcing

[redacted]

Findings Chart 2.20.2015

This is a brief chart summarizing key findings from the study. Please note that it this not meant to supplement the insights present in the study and should only be used after the report has been thoroughly read.



References:

Moore, G. (2014). *Crossing the chasm, 3rd edition*. S.l.: HarperBusiness.

Projected size of the global market for 3D printing, materials & associated services in 2014 and 2018 (in billion U.S. dollars). (2014, January 1). Retrieved January 15, 2015, from http://www.statista.com/statistics/315363/global-market-for-3d-priting-and-services/

Appendix E

Client Acquisition Memorandum:

An Analysis of 3D Printing Consumers and their Networks in the Silicon Valley

Demographics

- Highly educated
- Work in tech
- Diverse in gender
- Ethnically diverse
- Work in creative fields, especially 3D design
- Mean age is 34 years old, but vary in age
- Very similar to what you would expect in workforce of the SV
- More adult users than teens

A1. Consumer Networks

- The workplace is might be an effective space for introducing potential consumers into 3D printing because it is a tactile, in person, experience.
- "At my work, we were 3D printing some parts and I was asked to help with that process... We were printing inserts for syringes that our app would scan to measure the blood content...**that was the first time I ever used a 3D printer**" – Samuel, a recent college grad working at a Silicon Valley (SV) start-up, was introduced to 3D printing at work.

A2. Consumer Impressions About 3D Printing

- "Some of the things I would want to print are things like the structure of a protein molecule...**I would like to print it at high spatial resolution... each atom having a different color...[and make] the external layers of atoms transparent**...I don't know of any printer that could do that right now....**If I were to order something [online], I would want it to be of a higher quality than what you get with a standard [home] 3D printer**"– David, a physicist and engineer at a university biology lab.

3D Printing and the Media

- Most informants had heard of the 3D printed gun.
- This was not a selling point for consumers.
- Tactile campaigns might be more effective selling channels than by other media channels.

Quality

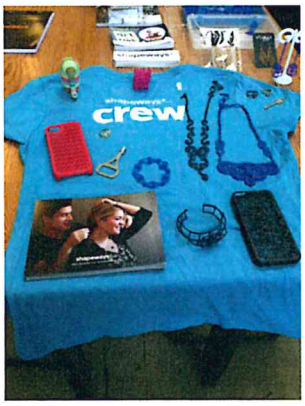
- Quality was extremely important to both home 3D printer users and Shapeways/online printer users.
- They defined quality by: durability, aesthetics, size, sharpness, accuracy, and complexity.

Functionality

- "I know of a friend mine's brother has a 3D printer and he uses it to make little nifty gadgets...Like he made an adaptor for his brother so that he could fit his favorite Nalgene water bottle, which is pretty wide, into his car's cup holder. **So for things like that it would be very useful. I myself am just not that interested in making unique kinds of things like that.** It's just not something that appeals to me." –Samuel.

Functionality Continued

- Functionality is tied to the intended purpose of a product.
- What some might think to be gimmicky can be seen as functional to others.
- Speed is considered an important function of 3D printing.
- Enjoyment was a function in and of itself.



Usability

- "I mean I don't think I would want to use it personally just because I don't have an interest in inventing new products...And also I don't have an interest in using it **because it seems like the process of making the design is really technical and complex and I just don't have the skills to do that. It's not the printing, the printing is really simple, but it's everything that comes before that, that is the complicated part.**" –Samuel.

Usability Continued

- Shapeways.com users had trouble with the iterative process of the site.
- It usually takes 2-7 iterations to get a model ready for online selling.
- Home users might be intimidated by printer maintenance.
- Findings suggest that online printing might be the most effective selling channel for new usuers because it removes many usability barriers.

Affordability

- When asked about whether he found 3D printing to be affordable, Matías, an 18 year old computer programming student stated: **"I don't find it to be affordable."**
- I asked him what he would be wiling to pay for a six-inch figure from an online 3D printer, he stated: **"I'd say depending on the part, and it also depends on the size of the thing. If I were to make something six inches tall, six inches wide, and six inches long [then I would pay] maybe 20 bucks total. For a larger piece, maybe thirty to thirty-five dollars total."**

Affordability Continued

- One user said that a cubic inch was probably 10 dollars worth of material. The truth is that it's cheaper than 10 cents.
- New users assume it to be expensive, whether online or offline.
- Experienced home 3D printer users know it to be cheap.

Affordability Continued

Common price brackets of 3D printing:

1) Home 3D printing, materials are cheap but printers are usually 1,600$-4,000$
2) Online printing, No printer cost, models are usually 30-600
3) High End Printing, out of reach for the average consumer 20,000$-500,000$ printers.

A3. Consumer Speculations About 3D Printing

"I think, or hope, that it will be used for high-volume 3D printing. Which is being able to mass-produce product. Right now it's more for low volume because it takes time to print parts... It would really excite me to have one, but for it to be the next washer and dryer, there will still be a lot to be thought of. **Right now I don't see it as the next washer and dryer because it's already out there, because not everyone is into designing or building. I don't think it will ever reach that point because I don't see a real use for it. Everything is so accessible at this time, with the click of the button. Why go through the hassle of designing stuff. Most people will likely buy [pre-made] stuff online.**" – Hector on the future of 3D printing. Hector thinks that 3D printing will have a greater influence in manufacturing than in home and personal use.

Potential uses cont'd

- Informants saw 3D printing as having the potential to significantly change manufacturing, medicine, and product consumption
- Brail for the blind
- Sculptures for students
- Prosthetic body parts for the economically challenged

Market Position and Strategy

- (Redacted)
- "It [3D Printing] seems like it requires of lot technical savvy for you to be able to benefit from it. **So maybe if 3D printers were designed in a way that people, like my dad who just got his first iPhone and has been using a non-smart phone, would be able to easily use and understand them. I can see that increasing the likelihood of me to use one**" – Samuel.

Strategy Cont'd

- (redacted):
- "You need to be able to design something without a 1,500 dollar SolidWorks license...If you work in the industry, there are very expensive CAD packages like SolidWorks. **There has to be something you know—maybe not as complicated—maybe not have all the features but something where you can design it in a 3D space relatively cheaply.**" –Colton on the need for cheaper and more usable modeling software.

Image redacted.

Strategy Cont'd

- **1. Knowledge Sharing (redacted)**
- **How to make it happen (redacted)**

Strategy Cont'd

- **2. Transformation (redacted)**
- **How to make it happen (redacted)**

Strategy Cont'd

- **2. Transformation (redacted)**
- **How to make it happen (redacted)**

Strategy Cont'd

- **3. Brand Expansion (redacted)**
- **How to make it happen (redacted)**

Strategy Cont'd

- **4. Optimized Utility (redacted)**
- **How to make it happen (redacte)**

Target Consumer

- Primary target consumer:
  - Age 18 years and up
  - Smartphone owner
  - From lower to upper-middle class
  - Creative
  - Not a 3D designer
  - Interested in new technology
  - Pragmatic in spending
  - Uses social media
  - Values high quality
  - Values aesthetic brands (i.e. Apple, Google)
  - Conscientious of environmental impacts

Target Consumer

- Secondary target consumer:
  - 21 years and up
  - Technically inclined
  - 3D designers
  - Do-it-your-self enthusiasts
  - Early adopters of new technology
  - Engineering background or job
  - Highly educated
  - Prefers quality over brand-name
  - Attend events like Maker Fairs or 3D printing MeetUps
  - Use websites like Shapeways or Sculptio

Four Gears Model

From *Crossing the Chasm 3rd Edition* (Moore, 2014)

Acquire traffic:
This process happens simultaneously with engagement. Acquiring traffic has two components: (1) onboarding new users who will eventually want new features and updates, and (2) producing new content and/or product features.

Engage users:
This one comes first and is the process of creating a compelling digitally mediated experience that keeps users coming back for more.

Monetize their engagement:
This one is very self-explanatory, but should be done carefully with regards to the business model and online features. Also, many digitally mediated companies run on a model that focuses on acquiring a mass amount of users first and generating revenue later.

Enlist the faithful:
This process can be understood as an evolved form of customer loyalty. Digitally mediated companies become successful because key customers develop an identity with the brand and are willing to evangelize the product to people in their network. This gear is based on the phenomenon of viral marketing and rapid consumer base expansions.

Four Gears

- Although an in-depth exploration into this model for strategy formulation is beyond the scope of this memo, it is important to consider the emerging market that Trnio's business model represents. (blank) has demonstrated viability for B2B marketing, such as e-commerce, but has also produced a digitally mediated product that requires B2C marketing. It is becoming harder and harder for tech start-ups to separate B2B from B2C because both seem to be converging. These concepts are foundational to the (company's) success and should be addressed in future meetings or projects.

B2C Marketing Campaigns

- (redacted)