Happy Plants & A Smiling Belly

A Look At the probable future of the human food system

By Bart Haney

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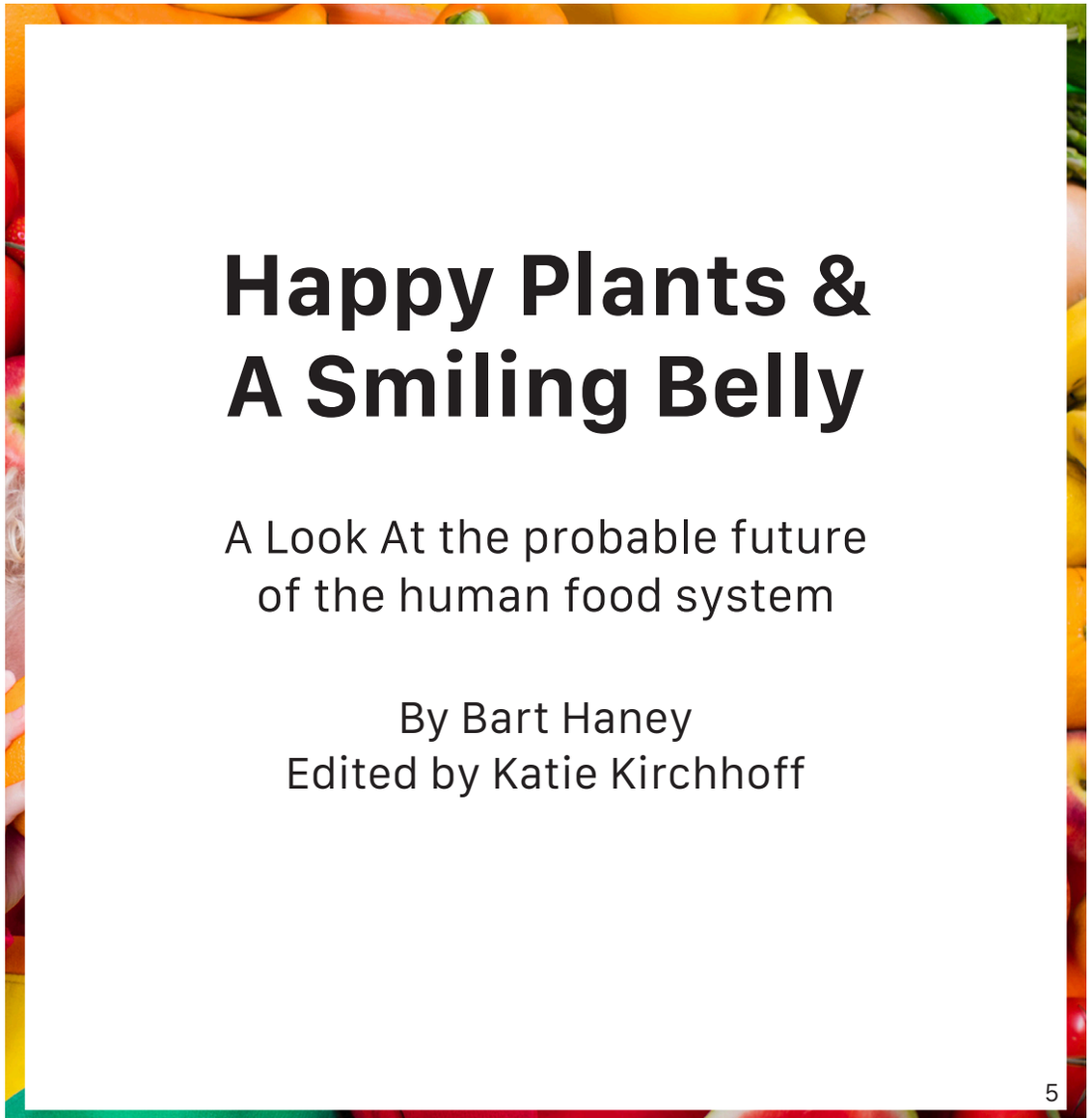

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By Bart Haney
Edited by Katie Kirchhoff

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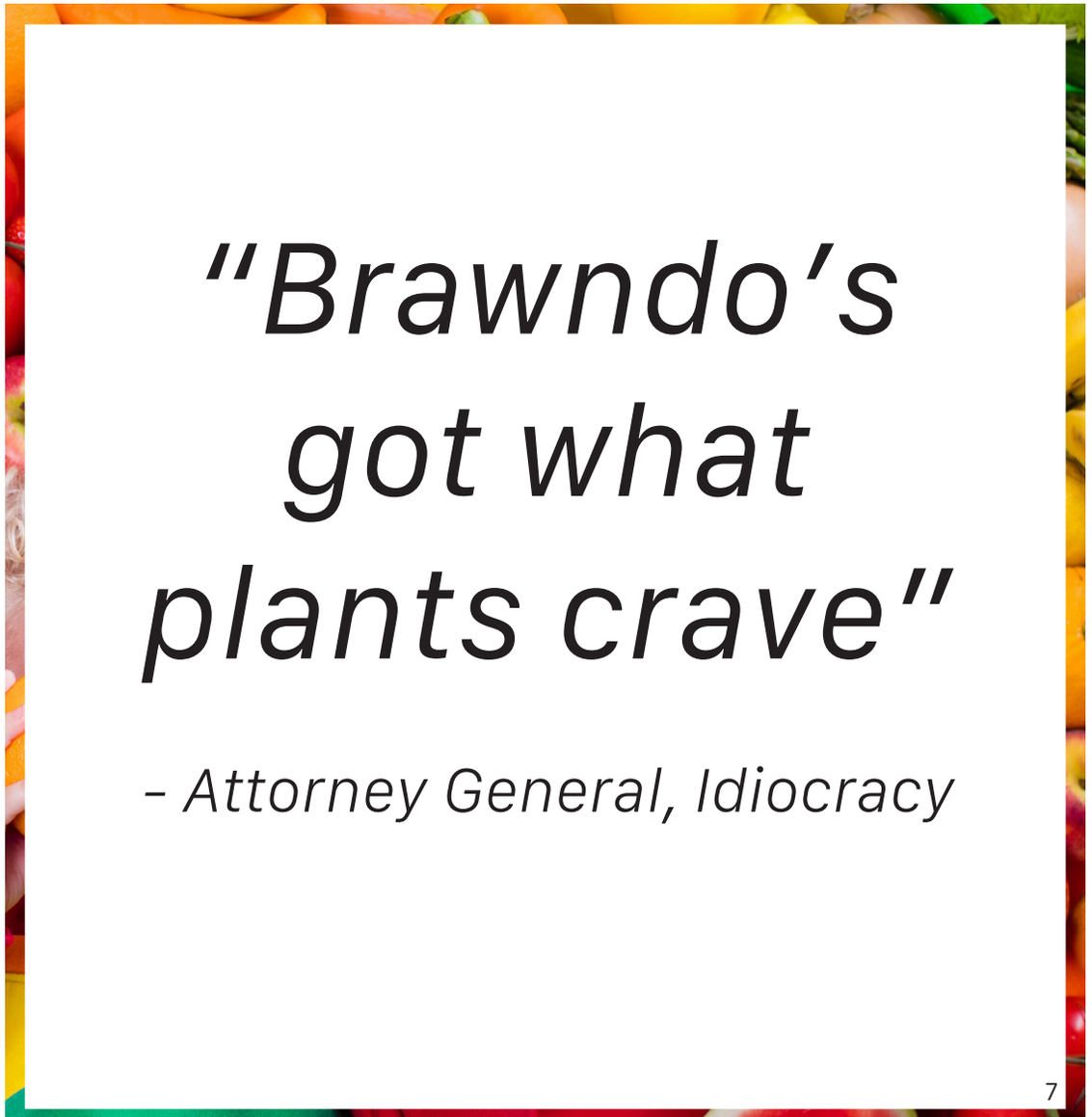

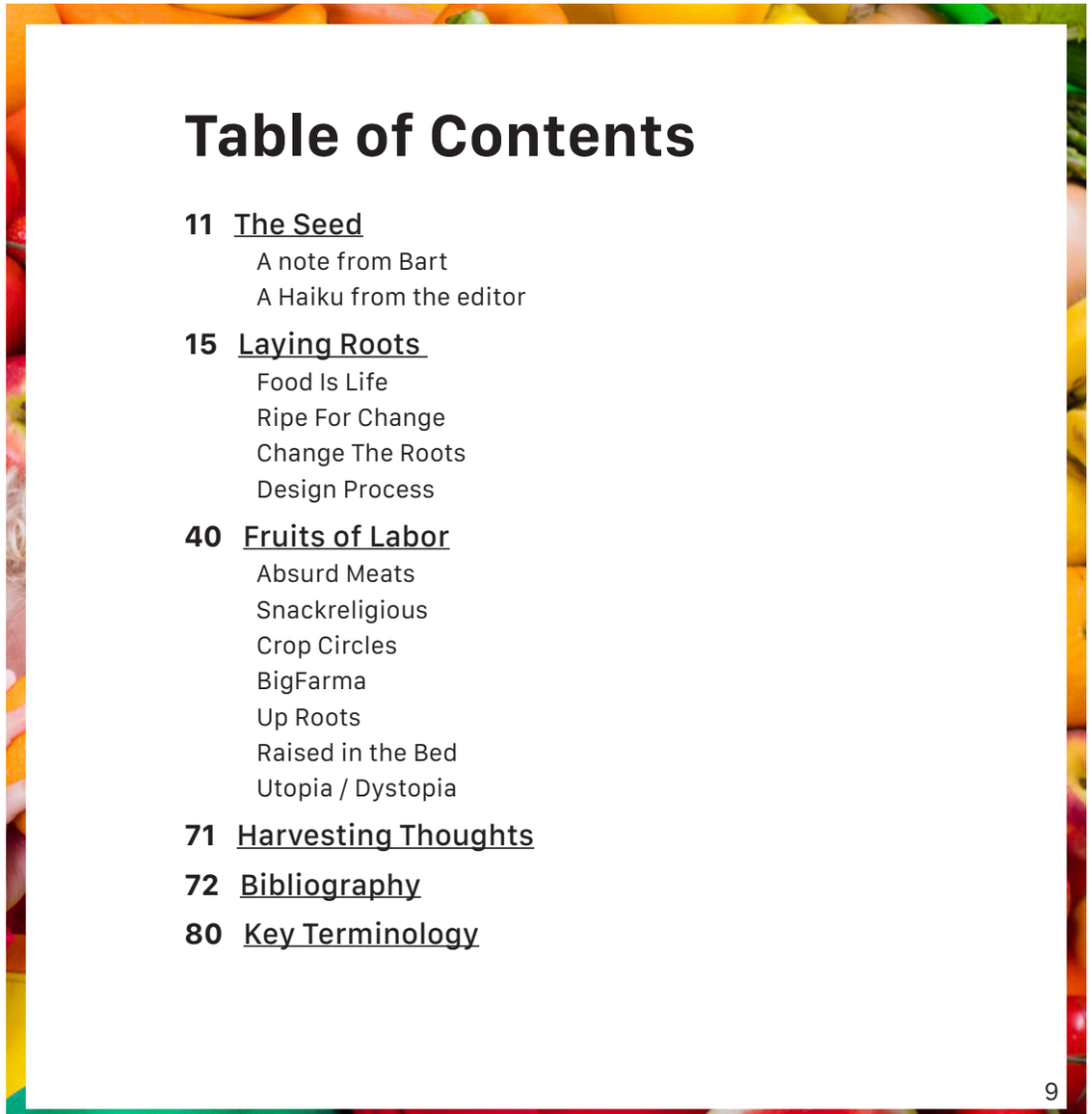

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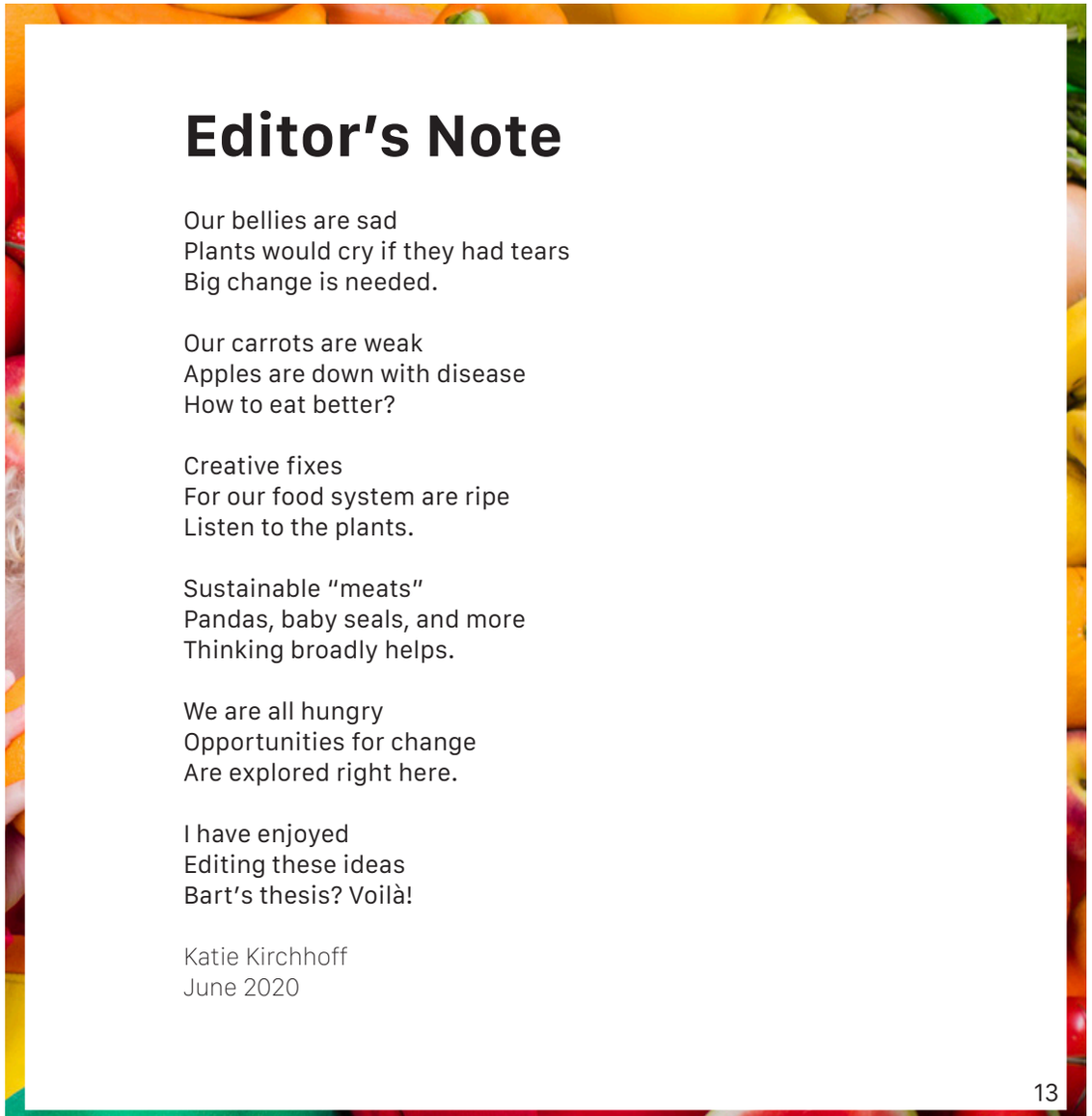
A Note from the Bart

My mother's side of the family have all been farmers. In quaint farms in rural Nebraska, they raised Angus beef, corn, soybeans, alfalfa and more. In addition to these cash crops grown for sale, my grandparents' farm existed in the era of self-sufficiency. The dairy cows were for milk, the chickens were for eggs, and the garden—full of tomatoes, peppers, carrots, and more—was used exclusively to provide sustenance for the family.

While I grew up in the the Big City of Omaha, I spent a considerable amount of my youth playing around on the farm and getting my hands dirty. (Yes, that's me milking the picture-perfect Holstein Friesian cow with my grandpa.) This cherished connection with classic American farming instilled a deeper understanding with the origin point for our food system as well as a deep reverence for the handwork and care that genuine farming takes. These memories continued to inform my thinking as I ventured to the coasts and lived my life as a problem-solving product designer.

As I approached potential topics for my thesis, I came to understand better how problematic food has become in our modern world. Empowered by personal experience, I decided to look deeply into a system that had lost its way. How could we reshape this system to provide better nourishment to people? How could I leverage my design skills to examine ways to get agriculture back to the roots of its intention, while also capitalizing on the bevy of new technologies and methodologies at our disposal to increase nutrition, reduce waste, and maybe even have some fun along the way? This thesis provides a springboard for beginning to answer some of those questions by delving into the probable future of the human food system.



Editor’s Note

Our bellies are sad
Plants would cry if they had tears
Big change is needed.

Our carrots are weak
Apples are down with disease
How to eat better?

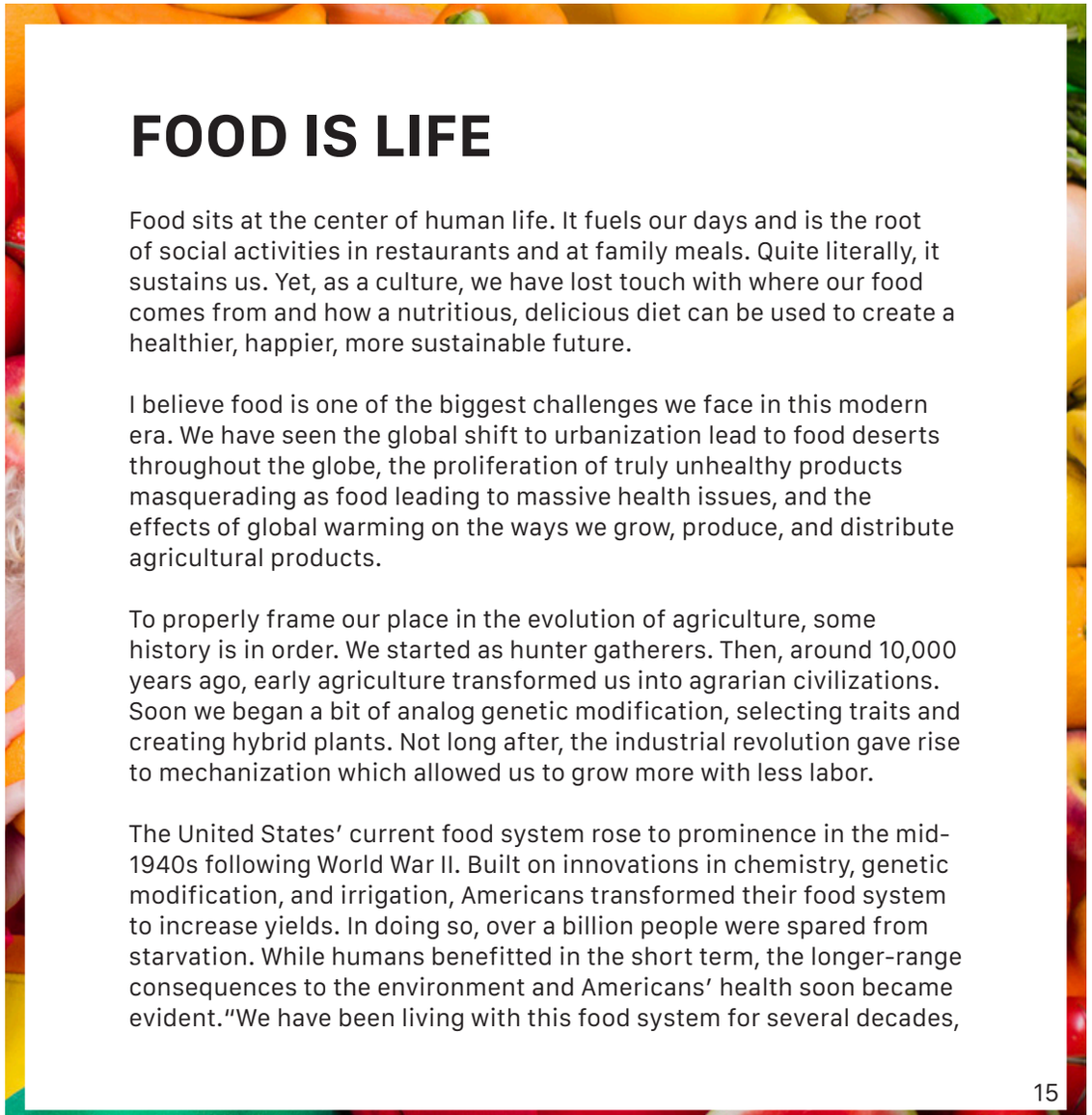
Creative fixes
For our food system are ripe
Listen to the plants.

Sustainable “meats”
Pandas, baby seals, and more
Thinking broadly helps.

We are all hungry
Opportunities for change
Are explored right here.

I have enjoyed
Editing these ideas
Bart’s thesis? Voilà!

Katie Kirchhoff
June 2020



FOOD IS LIFE

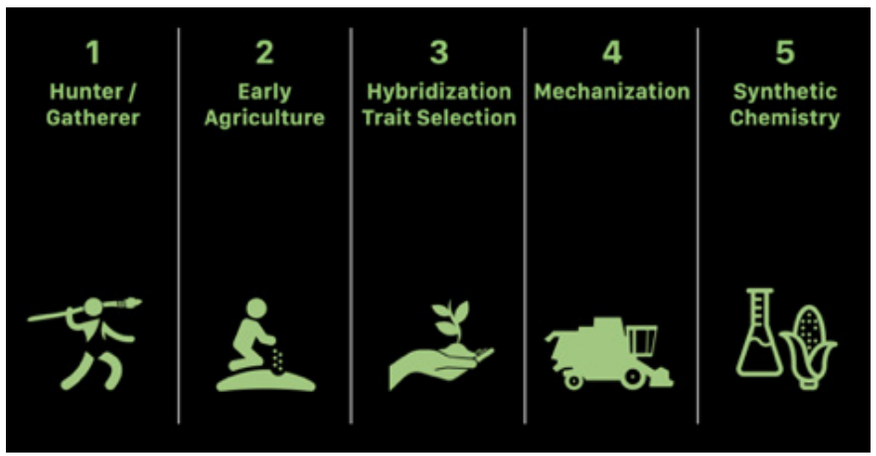
Food sits at the center of human life. It fuels our days and is the root of social activities in restaurants and at family meals. Quite literally, it sustains us. Yet, as a culture, we have lost touch with where our food comes from and how a nutritious, delicious diet can be used to create a healthier, happier, more sustainable future.

I believe food is one of the biggest challenges we face in this modern era. We have seen the global shift to urbanization lead to food deserts throughout the globe, the proliferation of truly unhealthy products masquerading as food leading to massive health issues, and the effects of global warming on the ways we grow, produce, and distribute agricultural products.

To properly frame our place in the evolution of agriculture, some history is in order. We started as hunter gatherers. Then, around 10,000 years ago, early agriculture transformed us into agrarian civilizations. Soon we began a bit of analog genetic modification, selecting traits and creating hybrid plants. Not long after, the industrial revolution gave rise to mechanization which allowed us to grow more with less labor.

The United States' current food system rose to prominence in the mid-1940s following World War II. Built on innovations in chemistry, genetic modification, and irrigation, Americans transformed their food system to increase yields. In doing so, over a billion people were spared from starvation. While humans benefitted in the short term, the longer-range consequences to the environment and Americans' health soon became evident."We have been living with this food system for several decades,

FOOD IS LIFE



we see the unintended consequences: growing massive quantities of the wrong food with massive collateral damage to the environment. While we degrade our health, our soil, and our water our, future food production capacity is at risk"(Seibel, May 2017).

Today's agricultural production methods are creating an ecological nightmare and diminishing biodiversity. The world economic forum states that three quarters of the world's food comes from just 12 plants (sugar cane, corn, rice, wheat, potatoes, soybeans, cassava, tomatoes, banana, onions, apples, and grapes) and five animals (pig, chicken, cattle, sheep, and goats) (Edmond, April 2019). Just three of these plants (rice, wheat, and corn) make up nearly 60% of all plant-based

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calories humans consume. Of the earth's estimated 400,000 plant species, we could eat around 300,000—yet we only eat 200. This lack of biodiversity in our diets ultimately limits our bodies' ability to access the nutrition in the foods we do eat (Conlon, Dec. 2014).

Humanity is clearly suffering from the effects of large-scale agriculture's focus on growing the most efficient crops without connecting those products to what humans actually need to eat for a happy and healthy life. Our modern farming practices are trying to squeeze out maximum yields without making appropriate attempts to support the crops, the topsoil, or the earth with genuinely ecological methodologies. At the same time, the vitality of the produce itself is being diminished.

Historically, consumers have not generally been concerned with increasing their diversity of diet or considering how their choices affect the health of the land. Instead, three major value drivers have determined what foods Americans purchase: convenience, price, and taste. As consumers have become more well-informed about the negative impacts of dietary choices on health, however, there is a growing awareness of the downstream implications of how farming and industrial agricultural practices can affect overall wellbeing. A meaningful example of this is the acknowledgment of the impacts on human health from pesticides and insecticides in our produce. Increased education about the widespread use of these potentially harmful carcinogens has led to a significant increase in the demand for organic fruits and vegetables. In fact, the U.S. organic market hit a new

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record high in 2018 with $52.5 billion in sales, more than double sales of the same category of foodstuffs from 2010 (Knutson, June 2019).

Larger changes are afoot as well. Consumer efforts to mitigate the impacts of industrial agriculture on the environment have had a substantive impact on the economic viability of businesses and brands. Accordingly, these inclinations are reshaping the ways that companies communicate about their products with their customers. According to the 2015 Deloitte Food Value Equation Study, evolving consumer preferences of health, safety, and ecological impact, in combination with the traditional drivers (convenience, price, taste) are fueling a new overarching desire for transparency in our food system (Renner, 2015). People want to know where a product comes from, how it is grown, what ingredients are in it, it's ecological impact, and how "good" or "bad" it is for them. Here lies a critical opportunity for designers and coalitions of stakeholders across the food industry to radically re-think and redesign current production models while also responding to consumers' desire for transparency across the system.

While almost all elements of our food system are primed for an evolution, this thesis focuses on ways to innovate the growing, harvesting, and distribution of fruits and vegetables. This can be done by addressing issues of sustainability, building on pillars of biodiversity as well as new innovations in industrial agriculture, and using opportunities created by new digital technologies. Approaching this issue both from the perspective of better serving human dietary needs and from a desire to create happier, healthier plants, the products of

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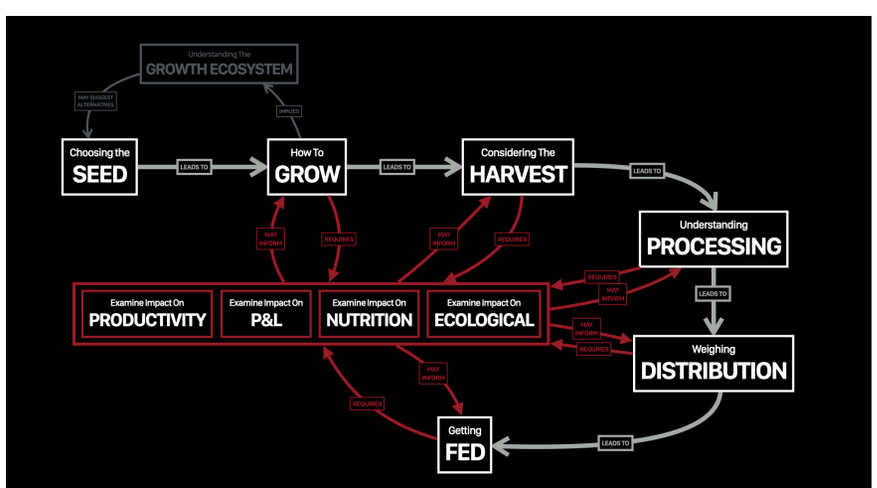
design explored here propose radical shifts in the design of public information as well as provocative products to heal a broken system, toxic lands, and unhealthy bodies. Now is the time to reimagine the production and distribution of fruits, vegetables, and synthetic proteins, bringing traditional foodstuffs in line with current and future needs, while building absolutely toward a healthier future full of happy plants and smiling bellies.

RIPE FOR CHANGE

Research published by scientists and engineers make it clear that the future of agriculture is in peril. Primary causes for this distress are large-scale industrial farming, global environmental shifts, and burgeoning population in urban areas.

As the health of people eating the contemporary western diet continues to decline with obesity, diabetes and cancer rates skyrocketing, new methods of farming, food distribution and public information have the capacity to deploy pointedly nutritious produce to help realign the health of this population by encouraging people to eat "right."



RIPE FOR CHANGE

From the individual diet to the farmer, as knowledge of the impacts of big foods' disregard for health and diet over profits grows, hyperlocal and hyper-personalized farming can effectively reshape mindsets as well as eating habits. Here, the farmer and the consumer might further collide in service of urban agriculture, rekindling our understanding of and relationship with where our food comes from and how it serves to nourish us.

Any discussion of our dietary challenges must necessarily draw on a well-studied understanding of the current food system. From seed to farm to factory to market to table, the path by which our food travels to our doorstep lies at the confluence of science, engineering, and design. Experts like Michael Pollan and Marion Nestle point out that this system is in dire need of change, and probable solutions lie with innovations in technology and in the evolution of the consumer mindset and associated behaviors.

Because the food system is massive and complex, and the scope of the challenges ahead are vast, this project considers two major areas of focus on the cusp of meaningful change: happy plants and smiling bellies.

HAPPY PLANTS

At first pass, one might think that this thesis argues for so-called "plants' rights." That isn't exactly the case, but history has demonstrated that healthy, long-term sustainable practices lead to healthy, long-term sustainable solutions. The aim of this project is to examine farming and the produce supply system with a curiosity about methods of agriculture that take into account the well-being—or "happiness"—of plants that will ultimately nourish people. To that end, this investigation will work to identify ways to nourish plants' essential needs, allowing our produce producing plants to reach their full potential; innovate farming and distribution processes to grow plants that can deliver optimal nutrition to consumers; and create a reliable system that can deliver the same, high-quality produce in perpetuity.

To bring to light areas of opportunity, it's helpful to better understand three areas where our current agro-industrial food system fails to support the needs of plants and thus impacts humanity's access to great nutrition.

1. Fields of Waste

Our current agro-industrial food system is a textbook example of resource use and pollution. Currently, agriculture accounts for 70% of freshwater consumption on the planet (OECD,June 2020). American farms use a billion pounds of pesticides every year; the impacts on

everything from cancer rates to affordability of food and water safety are profound (Manhas, June 2019). Greenhouse gases released in the form of methane from cattle and rice farms, nitrous oxide from fertilized fields, and carbon dioxide from deforestation to make space for crops and livestock, add up to more emissions than all our cars, trucks, trains, and airplanes combined (Foley, 2020).

Our current farming paradigm also gets high marks for wastefulness. Approximately 33% of produce grown never even enters the supply chain; it is either unharvested or left behind in the fields because the growers suspect it might not meet the specifications of their buyers (Anzilotti, July 2019). Moreover, approximately 40% of food in the United States goes uneaten after it has left the field: on average, that adds up to approximately 400 pounds of food per person every year. As Dana Gunders of the Natural Resources Defense Council notes, "Not only is that irresponsible—it's expensive. Growing, processing, transporting, and disposing that uneaten food has an annual estimated cost of $218 billion, costing a household of four an average of $1,800 annually" (Gunders, Aug 2017).

2. Nutrition Abhors Distance

The inefficiencies of today's industrial agricultural system don't end in the field. Compounding issues of taxing use patterns and waste, it turns out that the distance that foods travel from our farms to our tables seriously diminishes the nutrition and increases the cost of

produce. The Center for Urban Education about Sustainable Agriculture notes that grocery-store produce travels, on average, 1,500 miles from farm to plate (CUESA, Sept 2009). To further complicate this issue, an apple imported to California from New Zealand is often less expensive than an apple from the historic apple-growing county of Sebastopol, just an hour away from San Francisco.

Consumers ultimately pay for these inefficiencies. The long-distance, large-scale transportation of food consumes large quantities of fossil fuels. It is estimated that we currently put almost 10 kcal of fossil fuel energy into our food system for every 1 kcal of energy we get as food. This system works as long as fuel and transportation costs are cheap, but is a process begging for disruption. The implications of the distance our produce travels are further compounded by nutrient loss: fruits and vegetables lose, on average, approximately 30% of their nutritional value just three days after harvest (Eng, July 2013). Additionally, a University of California study showed that vegetables can lose 15 to 55% of vitamin C, for instance, within a week; some spinach can lose 90 percent within the first 24 hours after harvest (Rickman, May 2007).

While humans sacrifice nutrition because of the time it takes to get produce from field to plate, our soil is also losing the capacity to properly nourish the produce growing in it. Because our agro-industrial system has so heavily taxed the land, studies have revealed that fruits and vegetables grown decades ago were much richer in vitamins and minerals than the varieties most of us are familiar with today. A

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2004 study of the U.S. Department of Agriculture's nutritional data of 43 different vegetables and fruits showed "reliable declines" in the amount of protein, calcium, phosphorus, iron, riboflavin (vitamin B2) and vitamin C over the past half century (Scheer, April 2011). A similar study of nutrient data from 1930 to 1980, published in the British Food Journal, found that in 20 vegetables the average calcium content had declined 19%; iron 22%; and potassium 14% (Marles, Mar 2017).

The diminished nutritional value of today's produce is directly linked to soil depletion: modern intensive agricultural methods have stripped increasing amounts of nutrients from the very substrate that serves as a foundation for the food that we eat. To create a relatable example, one would have to eat eight oranges today to derive the same amount of Vitamin A as our grandparents would have gotten from one.

3. Change for Climate

While the inefficiencies of industrial food production and its effects on the land cannot be ignored, there is another, even bigger issue that affects our relationship with the future of food: climate change. Alejandra Borunda paints a picture of the northern migration of our climate being similar to what is happening 500 miles to the south. The author notes, "Want a glimpse of Washington, D.C.'s climate future? Take a road trip down to Greenwood, Mississippi. In just a few decades, as climate change heats up the planet, that same swelter is likely to be de rigueur in D.C. Meanwhile, down in Mississippi, seasons will morph

into something like those in northern Mexico today" (Borunda, Feb 2019). These projections are even more arresting when directly linked to the effects of climate change on agricultural production across the globe. Consider the midwest, the breadbasket of America. This entire region is contained in the upper part of the United States, and if Borunda's projections are accurate, almost the entire growable area of the breadbasket will migrate north out of the United States and into Canada. This would have a catastrophic impact on the prosperity of this region—both relative to grain production and from the perspective of the loss of industry related to the infrastructure built to harvest, transport, process and deliver these products to consumers. Similar impacts would happen to nearly every other crop that is raised across the globe?

SMILING BELLIES

Smiling Bellies examines humans' fundamental need for food and connects that demand with scientific insights that help us better understand what humans should do to actually eat "right." Additionally, Smiling Bellies examines the ways that people shop for produce; evaluates the role of produce in nutrition, health, and diet; and asks how advances in technology and science can inform and enable a more transparent relationship with what we eat, where it comes from, and what is does for us inside our bodies.

1. Our Diet is Killing Us

Our diet—and diet-adjacent maladies like obesity, diabetes, and cancer—is the outcome of industrial food production. Look into your pantry and fridge. What percentage of the foods you consume come directly from a farm? What percentage hail from an industrial source? In some cases, it's easy to spot the difference. But in the past ten years, we've also come to realize the extent to which our "natural" or "whole" foods—meat, dairy and produce—are the result of industrialization.

Food is life, yet we are currently eating such an imbalanced diet that we are literally killing ourselves. According to the Center for Science in the Public Interest, unhealthy diet contributes to approximately 678,000 deaths each year in the U.S., due to nutrition and obesity-related diseases, such as heart disease, cancer, and type 2 diabetes (CPSI,

2016). Nearly half of the population has one or more chronic health conditions, such as diabetes, asthma, heart disease, obesity, or cancer (Raphael, March 2019). These stats shouldn't be surprising when you consider the fact that highly processed foods make us more than 60% of the calories in the foods U.S. grocery consumers buy, and these items tend to have more fat, sugar and salt than less-processed foods (FASEB, March 2015). In fact, in a 2018 study in which northwestern Medical scientists analyzed 230,156 products in grocery stores and found 71% of products were considered ultra processed by the NOVA standard. (Samuelson, July. 2019) These are foods which consist of industrial formulations made entirely or mostly from substances extracted from foods (oils, fats, sugar, starch, and proteins) They are derived from hydrogenated fats and modified starch, and are synthesized in laboratories. Yum.

Despite consumers' best efforts in making good decisions, the food industry works hard to obfuscate objective health data on packaging. Despite 48% of consumers who consulted crowded food packages for guidance, shoppers claimed that identifying healthy food was difficult (11%) or moderate (61%) (Newby, Aug. 2019). While some labels are meaningful, the content of most are little more than cleverly disguised marketing. Food futurologist Morgaine Gaye has noted, "Right now we're in a time where we have a lack of trust. We don't really trust our governments in the same way. we don't trust the world in the same way, the banking system, the supply chain. We don't really trust that we can be made well anymore. It can't be fixed with a magic bullet at the doctors. We're starting to see people younger and younger with

terminal diseases terminal illnesses. So the question then comes up, how can we prevent that, how can we have preventative care, and of course that's food" (De Clerck, 2017).

The world would be better served if we heeded the advice of food experts like author Michael Pollan. Pollan implores readers to "Eat food, not too much, mostly plants."(Pollan, Jan. 2007) These kinds of approaches are indicators that there is a growing case for using fruits and vegetables as part of a massive reevaluation of the ways we think about healthcare. This proposal has the potential to positively impact health while also functioning as an efficient, cost-effective way to move American consumers toward a more healthful future. A study from Tufts University tested this, tracking medicare patients in a scenario in which the costs of 30% of their fruits and vegetables were subsidized. Not only did the subjects rely less on healthcare, but the increases to a nutritious diet were projected to prevent approximately 1.93 million cardiovascular events (such as heart attacks) and 350,000 deaths. Moreover, the switch to a more healthful, plant-based diet cut collective healthcare costs by $40 billion (Lee, March 2019).

2. Going with our Gut

Industrial agriculture is one of the biggest drivers of diminishing biodiversity. The narrow band of crops the world is currently growing for food not only narrows the gene pool of plants, but also has important implications for the health of people eating those plants.

RIPE FOR CHANGE

A National Center for Biotechnology Information study showed that a diversity in diet gives rise to greater diversity in the human gut biome. In turn, a more diverse gut biome drives the human body to better access available nutrients from the foods we consume (Conlon, December 2014). Guru Banavar, the Chief Technology Officer at Viome, offers this critical insight: "The important thing to remember is that it isn't the food you eat but what your gut microbiome does with the food you eat that matters most when determining what foods are "healthy" for you" (Olayanju, Oct. 2019).

New understandings of how the gut helps humans lead healthier lives have shifted the ways we think about nutrition at the individual level. In the last decade, the scientific community has discovered that within our bodies are trillions of bacteria that play critical roles within the human body (Clemente, March 2012). These bacteria affect every aspect of our living, especially with regard to the ways that the human body processes and uses nutrients. Understanding and studying how gut microbes react to nutrition and how these reactions affect human metabolism is powering a revolution in our understandings of overall nutrition, how nutrition impacts the human body, and how changes in our nutrient intake impact our risk of developing common diseases.

While a diverse gut biome increases humans' ability to use more of the nutrients in the foods we eat, scientists are studying how we can better feed the differences in individuals' gut biomes through targeted, nutrient-rich foods. Mathematics engineer Eran Segal and immunologist Eran Elinav at the Weizmann Institute in Tel Aviv have

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been conducting a study that capitalizes on the discovery of the value of our gut's microbiome, ultimately aiming to use the results of the investigation to revolutionize our eating habits. By assembling a panel of 1,000 volunteers and implanting sensors under subjects' skin, Segal and Elinav were able to monitor subjects' responses to the consumption of various foods in real time. Using those data points, Segal and Elinav devised an algorithm that informs test subjects what foods are best suited for their individual gut biome (De Clerck, 2017). Studies like these allow us to look forward to a future where humanity better understands the health and wellness implications of each meal on overall health. The collective impact of these kinds of investigations could someday inform individual eaters about precisely what they should be eat to promote and maintain their healthiest life.

3. Techno-Transparency

While much of this thesis focuses on improving the quality of the fruits and vegetables we eat, there is more to the story. Part of the puzzle involves addressing issues surrounding the technologies that enable these kinds of innovations—both in the supply chain, and also as tools to empower consumers. This is especially critical when we recognize that our agro-industrial supply chains are presently the least digitized of any industry (Seibel, March 2017).

Thankfully, we are not starting from scratch. The industry has already developed facial recognition software that functions to identify

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individual cows and track herd health, as well as robots that use machine "vision" to pick fruit. There are also "smart sensors" that track a range of data, from plant nutrients to soil moisture. These examples prove that the technology needed to revolutionize agriculture already exists; the challenge today is that these technologies are being developed in silos with limited integration (Manhas, June 2019).

Opportunities for substantive growth abound. There is an opportunity to combine advanced sensor technologies with artificial intelligence to create sophisticated surveillance and control systems with the potential to improve food productivity, enhance sustainability and benefit the environment (McClements, May 2019). The near-future of technology enabled agriculture will no longer depend on decisions at the farm be made through human observation and trial and error. Decisions about how to grow food and how much to grow will be based on the measurement and analysis of biodiverse ecosystems with digital data collection, big data science, and sophisticated analytics (Seibel, March 2017). A critical step in moving forward is to bust the lingering myth that technology is the enemy of natural, abundant, and affordable food. Agricultural Technologies (AgTech) is the way we get there (Manhas, June 2019).

Looking deeper at the global issue of food and health, there are spaces for AgTech to go beyond the straightforward task of growing better, healthier, more efficient and nutrient-rich produce. Meaningfully, AgTech has the power to help the general public connect the dots between what consumers purchase at the grocery store—and what

RIPE FOR CHANGE

those consumers, in turn, put in their bodies at dinner—and the complex growing processes that the average consumer rarely sees (Manhas, June 2019). If consumer needs and desires are digitally connected with a dynamic supply chain, the opportunity exists to generate sophisticated forecasts that can allow modern farmers to grow precisely what is needed, when it is needed. This bespoke system allows us to waste less (Seibel, March 2017).

AgTech can also provide consumers helpful information about where their produce comes from. Before the advent of industrial agriculture, a trip to the local grocery or farmers' market had the capacity to connect consumers directly with farmers. As the industrialization of the food system expanded, consumers became disconnected from this information and a corrosion of consumer trust became evident. The rise of technology in our agriculture has the opportunity to reconnect us with traditional agricultural traditions. Sensors are monitoring the process of growing and digital tools enable us to track not only where our food comes from, but how it was tended to. Food futurologist Morgaine Gaye notes that as consumers, "We're changing, we're getting clever. We want to know where [our food is] from, how it is made, what's in it. What does it do for us and how is it going to make us feel… As time goes on, we're going to be more demanding. We're going to have a lot of digital input in our choices" (De Clerck, 2017). In a meaningful way, this offers opportunities to rebuild consumer trust with transparency.

CHANGE THE ROOTS

Every historical transformation in our food system—from the rise of agriculture to industrialization—has solved a problem of the previous generation. Armed with the tools of design, in combination with new technologies and agricultural processes, opportunities exist to solve for how to grow appropriate amounts of desirable produce in ways that bolster the wellbeing of our planet while also servicing the health of our population. A natural springboard for ideation lies in the relationship between consumer choice and the larger supply chain that brings food to the table.

Designing production solutions to mitigate fields of waste; lessen the distance from farm to table; reduce our impact on the environment; and address consumer demands for health, diversity, and transparency can be accomplished by addressing the problems at scale. Ripe opportunities for design interventions emerge when considering the following principles:

1. Alert consumers to opportunities to demand change with bold, provocative ideas.

2. Recognize and build capacity for AgTech to bridge the divide between plants and people.

3.Leverage science and consumption to create opportunities for consumers to feel empowered and in control of their relationship with food and their health.

CHANGE THE ROOTS

What can and should we do about this? It makes sense to critically evaluate the declines in human health, the growing cycle of our plants, and how we distribute produce, as the promise of controlled environment agriculture continues to rise in the public consciousness. What if we grow the produce that our diets demand, not what is efficient to grow? How might humans benefit from an overhaul of the current agricultural system to pivot towards future resiliency so that we become less dependent on global climate changes and the draw on natural resources?

Empower Consumers

How will be make these transformations stick? The answer lies in empowering the consumer.

Not so long ago, people knew where their produce came from. As the industrialization of our food system increased, we got further and further away from this connection. Industrial agriculture is largely to blame for this disconnect. The rise of technology in our agro-industrial food system has the opportunity to reconnect us with our foods. It offers opportunities for constructive innovation aimed at bringing consumers, nutritious food, and healthy eating back to the table. To use technology to re-educate and re-connect consumers. According to Karn Manhas , "The challenge for AgTech is to help the general public connect the dots between what they buy at the grocery store and put in their bodies at dinner and the complex growing processes they rarely see" (Manhas, June 2019).

Transparency and Innovation

There lies an opportunity for designers and coalitions of stakeholders across the food industry to radically re-think, re-shape, and redesign current models of growing, distributing, and consuming produce in ways that specifically address resiliency by building on the pillars of biodiversity, new agricultural methodologies, digital technologies, and consumer-industry transparency.

This rise of technology in our agriculture has the opportunity to reconnect us to our food. Opportunities for this exist already: sensors can monitor the process of growing, while additional digital tools enable tracking not only where our food comes from, but also how it was tended to. In these ways, consumer trust can be reignited with transparency.

Innovation today might look like indoor growing systems that utilize urban verticality to move agricultural products from rural, faraway farms to growing centers in more urban areas where critical populations of consumers live. Urban agriculture could lead to reduced use of water, fertilizers, and pesticides. It could also make the food supply more robust and secure. Kwon notes that "Cities could have fresh crops from vertical farms even if arable lands suffer major disasters." Moreover, Wilcox notes that "Vertical farms are almost pathogen- and disease-free"(Wilcox, Feb 2020). Moving plants out of the soil and into hydroponic facilities close to population centers means you can grow nutrient dense, fresh produce, using 90% less

water, harvest daily and year round, create less food waste, and grow nearer to major population centers (Seibel, March 2017).

You Are What You Eat

Medicine has historically been tied to the foods we eat. Generations upon generations of healers and medical practitioners have studied the medicinal (as well as the toxic) properties of plants. Ginger to settle the stomach, willow bark to relieve headaches, ginseng to give energy, carrots for the eyes, garlic for the heart. Many people continue to turn to food for palliative care. Moving into the future, we can superpower this connection with the ability to precisely monitor the variable inputs of controlled environment agriculture to growing precisely nutritious produce and connecting it to the emerging data from our bodies micro-biome, we can begin to blur the boundaries between food and medicine. In other words, "Instead of treating disease through medicine, we believe that food itself should be medicine" (Yee, Feb 2019).

Design Process

Tackling the challenge of using design to address some of these industry and consumer concerns was executed with a tight selection of design tools and methodologies. The fledgling step was personal immersion into the field. The project began with a significant amount of research into secondary sources related to the state of both our plants and our bellies as well as interviews with a selection of subject matter experts raging from dietitians to molecular scientists to NASA satellite technicians.

Co-Creation Workshops

Stepping forward with this information, a dive in to consumer behaviors was excavated through a co-creation workshop which delivered first hand information into the shopping processes of some modern consumers.

Mapping systems

All of this information was amalgamated into system maps to discover rich opportunity areas to disrupt and evolve the consumer experience in shopping for produce.

Prototyping

The design process from here dove into a myriad of ideation, sketching, prototyping, and modeling to establish the concepts you will see in the following chapters. These concepts function in a myriad of ways

to address the inefficiencies and extant opportunities within our current food system. Absurd Meats and Snackreligious function to turn consumer thinking on its head, reshaping the ways we approach ideas of what is sustainable, cravable, and healthy for our bodies. Crop Circles and UpRoots bring far-flung production traditions to centralized locations, diminishing the distance between farm and consumer while cutting down on waste and salvaging the critical nutrition that is usually sacrificed with common modern agricultural-industrial processes. Finally, BigFarma brings consumers together with new digital technologies and high-quality, pointedly-nutritious produce that is specifically designed to address health deficiencies on the individual scale. The collective opportunity with these products of design is a quantifiable improvement in the overall health and wellness of human populations at a larger scale.

Absurd Meats

Absurd Meats

Why limit yourself to what you already know

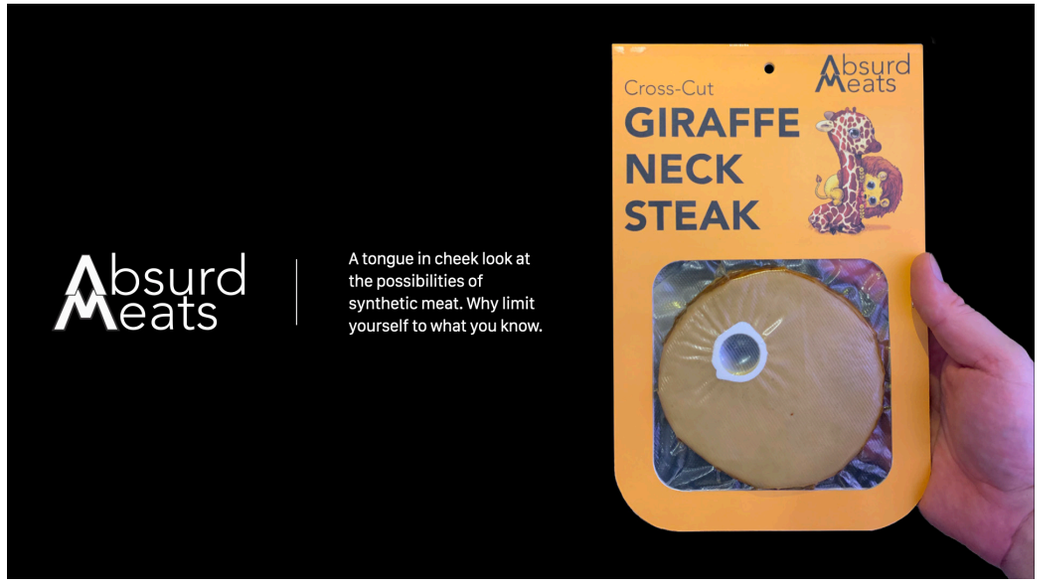
Absurd Meats — a tongue-in-cheek take on the possibilities of synthetic meat — rewrite the potential of lab-grown plant-based protein products, with each product inspired by an animal that exists outside of the mainstream food culture. With products like Freshly Clubbed Baby Seal, Cross-Cut Giraffe Neck Steak, and Nearly Extinct Panda Paw Nuggets, Absurd Meats provoke consumers and designers to reconsider the trend of recreating natural meat products with synthetic proteins. Opportunities for edible adventures exist within the limits of the imagination, and can now be realized in engineering facilities with the cornucopia of flavors and textures available from modern food science. Absurd Meats exist as a challenge to the modern agricultural-industrial complex and a call to food science professionals who are committed to developing a spectrum of tasty, planet-friendly, highly nutritious spectrum of meat alternatives for 21st-century consumers.

Absurd Meats

Freshly clubbed baby seal is back on the menu.

“Why limit yourself to what you know” says founder Bart Haney as he heats up a fresh serving of ‘Nearly extinct Panda Paw Nuggets’ Nebraska-based Absurd Meats has recently launched their line of vegan synthetic meats aimed at rewriting the potential of lab-grown and plant-based protein products. Each product is drawn from an animal that generally exists outside of the mainstream food culture. Punchy products like Freshly-Clubbed Baby Seal, Cross-cut Giraffe Neck Steak, and Nearly-extinct Panda Paw Nuggets help provoke consumers and food designers to re-consider the trend of recreating natural meat products with synthetic proteins.

“Instead of opening up the range of potential with lab-grown and plant based meats, the industry is currently only focusing in on trying to recreate what we already know with burgers, bacon and sausage,” proclaims Bart. “The real opportunity lies in the limits of our imagination which can now be realized in the modern edible engineering facilities like we have developed at Ritual Disruption Labs, the parent company of Absurd Meats. A cornucopia of flavors and textures are available to develop a spectrum of edible enjoyment through our highly nutritious products.



Snackreligious

Stealthy Healthy Junk Food

We all crave junk food, be it cake, candy, or quesadillas, but science tells us that eating healthy is important for a long battery life. Using the power of food science for good, Snackreligious transforms unappetizing, nutrient-rich foods into stealthy healthy junk food on demand. The consumer experience begins with a trip to the Snackreligious web site. The interface allows users to list their most deeply desired junk foods and share some of the dietary goals they would like to realize. This data is then sent to the Snackreligious food lab where the craveable snack's process, texture, flavor and nutritional properties are engineered. Tasty, nutritious treats are then custom-manufactured and packaged in our plant-plant, and the newly designed craveable snack is prepared for shipping to the client. Customers can choose to set up recurring shipments weekly or monthly, with details managed through the consumer web interface.

// Behind the Scenes

The users go to the web and pick their most deeply desired junk foods. *(corn dog, doritoes, chocolate cake)*
The user then shares some of the dietary goals they wish they were following through on.

In our food lab, the craveable snack's process, texture, flavor and nutritional properties are engineered.

Snack is custom manufactured and packaged in our plant-plant.

The newly designed craveable snack is packaged and mailed to the user.

// Deliver

Each week a new box of stealthy healthy snacks arrive at your door.

10x Chocolate Wafer

7x Gummies

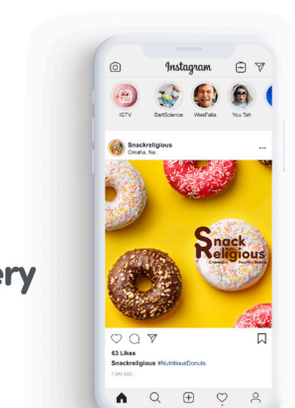
5x Bag of Chips

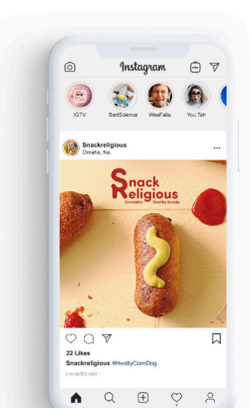
2x Tube of Donuts

3x Personal Pizza

// Instagram

Grab users attention with craveable imagery





Snack Religious
Craveably Healthy Snacks

Tollhouse Chocolate Chip Cookie

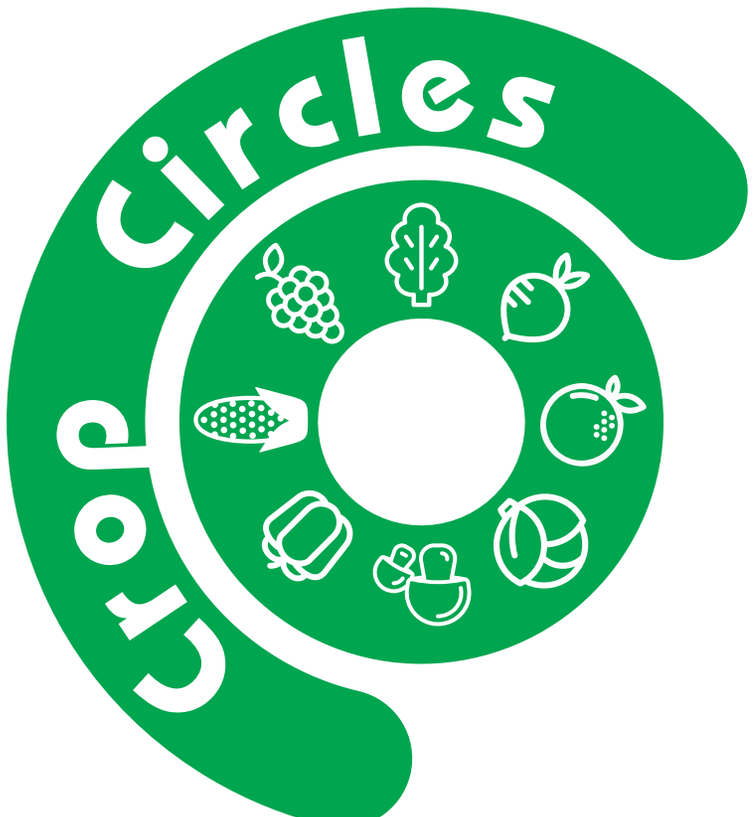
(all-purpose flour, refined sugar, brown sugar, butter, salt, eggs, semi-sweet chocolate chips)

- 180 Calories
- 2g Protein
- 24g Carbohydrates
- 2% RDA Vitamin A
- 0% RDA Vitamin C
- 0% RDA Calcium

Snackreligious Chocolate Chip Cookie

(high-protien flour, stevia, avocado-butter, vita-salts, legumes, nutrition-infused chocolate chips)

- 90 Calories
- 18g Protein
- 12g Carbohydrates
- 30% RDA Vitamin A
- 22% RDA Vitamin C
- 35% RDA Calcium

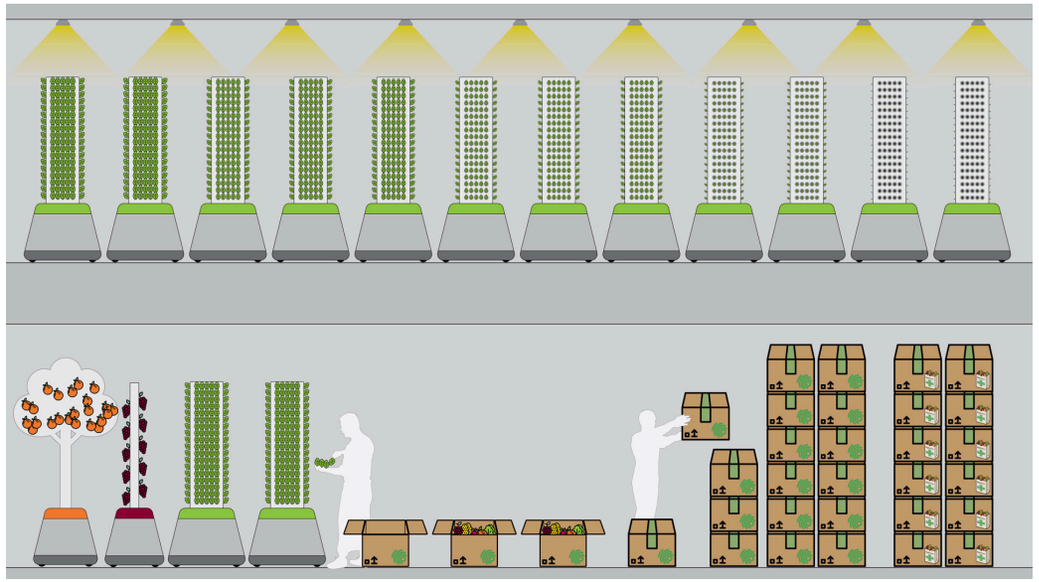


Crop Circles

Bespoke produce

Crop Circles is a modern farm share infrastructure that cultivates fruits and vegetables locally in precisely controlled indoor farms and delivers produce to customers' doors within hours of harvesting. This approach gives Crop Circles the capacity to deliver seasonal favorites, all year round. Have spaghetti squash arrive just as fall rolls in, or if winter gets you down, have a summer feast of fresh corn, juicy watermelon and some bursting blueberries delivered on a cold winter afternoon.

Crop Circles' technologically integrated farming process enables users to be engaged with and informed of their produce's progress. Using a digital platform, shoppers select crops for the week, the month, even the year. Each piece of produce is then specifically grown for each customer, harvested, and delivered to the client's doorstep within 24 hours. The latest advances in lighting, environmental controls, and nutritional delivery enable crops to be cultivated to the demanding needs of each and every plant. The growing cycle for the produce uses a "Root Train" process in which a series of sequential plants have the beginning of their growing cycles offset in such a way that enables picture perfect produce ripening each and every week, all year long. This leads to a quality of product generally unachievable in typical grocery stores and CSAs. Moreover, because each piece of produce is grown on demand, customers aren't limited to the narrow selection at



Select Crop

Precise + Local Hyper-Farming

Harvested and Delivered within 24h

Weekly produce to your front door

BigFarma

Producing Better Health

BigFarma is a new tool for social medicine that closes the loop of care. Envisioned to help borderline symptomatic individuals struggling to manage the onset of chronic diseases like heart disease, diabetes, and obesity, BigFarma uses food as a first level of prevention and to support medication in treatment. Subsidized by the national medical system, BigFarma provides prescribed fruits and vegetables that function like prescription medications. Using a connected ecosystem of health professionals, intelligent nutrition algorithms, and modern farming practices, BigFarma explicitly connects a client's overall health with food to fight the onset of diet-related diseases.

The BigFarma process is simple and dynamic. In concert with a user's doctor or healthcare professional, samples are taken to study the client's body chemistry, develop a DNA profile, and create a map of their gut biome. Data is aggregated into an app, illuminating the customer's current nutritional levels and a progress warning for chronic diseases. Intelligent nutrition algorithms then generate a unique ideal diet outline for the user, recommending healthy foods that deliver essential nutrients and driving overall physical health in a positive direction. The BigFarma app also allows users to assemble specific meals to be grown and delivered. A service like Crop Circles would grow produce to precise demands, even priming the growing environment to maximize nutritional yields for each piece of produce. Meal kits, including recipe cards and the nutritionally rich produce used to prepare them, are delivered to a customer's door within 24 hours of harvest for maximum nutrition.

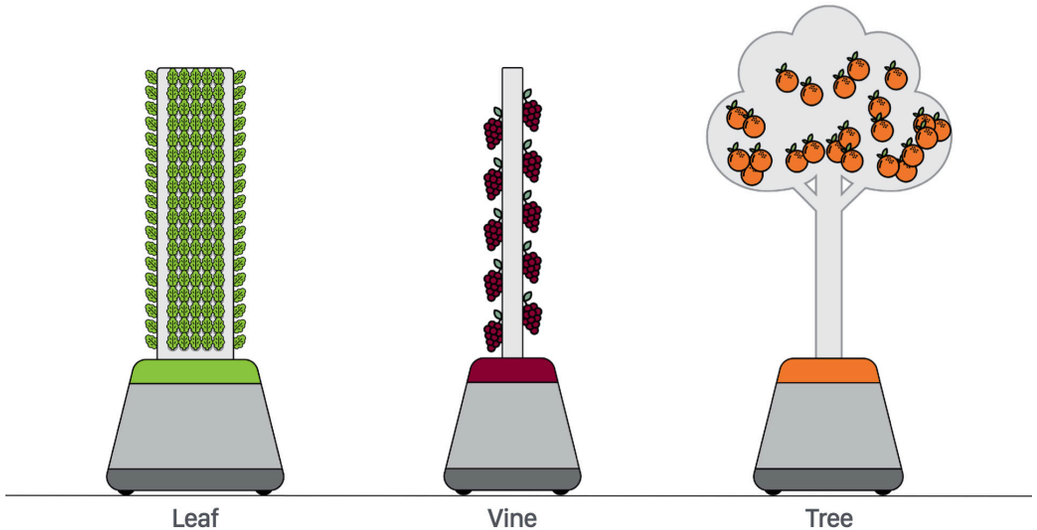
1. TEST 2. MAP 3. MEALS 4. GROW **5. DELIVER**

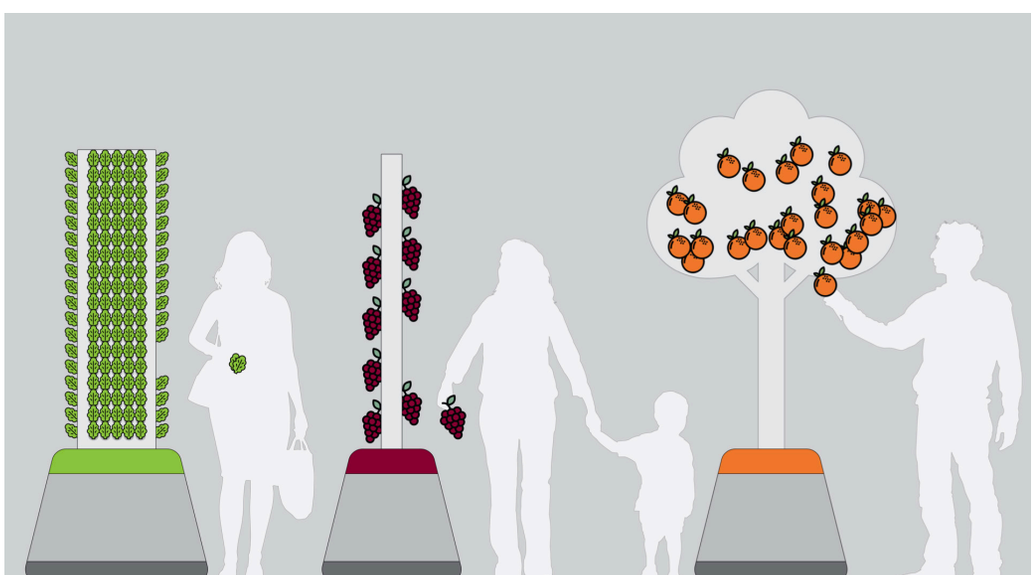
Up Roots

Modular Farming GrowCarts

Imagine walking into a grocery store and pulling juicy grapes from the vine, plucking tart oranges from a tree, or ripping a sweet ear of corn right off its stalk. UpRoots modular farming GrowCarts provide an opportunity to realize this fantasy on the shopping floor, allowing users to literally pick the freshest, most nutritious produce possible.

Created to enable businesses to grow produce on site, each modular UpRoots GrowCart is a foundation for a controlled-environment agriculture infrastructure and can be set up anywhere with access to a water supply and natural or artificial light. Crops are grown under controlled lighting and are fed water uniquely engineered to give precise nutrients to each specific plant type, assuring healthy yields from happy plants. A "Root Train" process is employed to guarantee a perpetual supply of product, allowing for accurate calculation of production quantity while consistently delivering perfectly ripe fruits and vegetables to hungry customers, all within a single building. GrowCarts can also be deployed to harvesting facilities for Crop Circles and BigFarma, trucked out to satellite grocery stores, or moved down to the consumer grocery store floor. With portability built into their DNA, produce-laden GrowCarts from a central hub also have the flexibility to be loaded onto trucks and shipped to regional markets, providing options for users located in both high-consumption areas and food deserts.


Leaf
Vine
Tree




// Animation
Roots Grocery

RAISED in the BED

Urban Ag Food truck

RAISED in the BED is an experiment in having people experience the difference that truly FRESH ingredients make and to experience the future of food which is enabled in urban environments by the modern forms of controlled environment agriculture.

The vision is to:

1. Empower People to navigate the world of food ~ nutrition with an informed sense of confidence
2. Connect People's Health Needs With What They Eat
3. Act as a Roadshow for Future Farming

How it works:

There is a fresh supply of unharvested greens at the front of the order line. These are contained in Square Root container farm green wall. A salad concierge helps participants learn about the greens. Participants then leaf through the selection of greens from the living wall and and select their salad base.

Participant harvests their leafy greens of choice from the wall with a lettuce knife and hands them off to the cart chef where a fresh salad is tossed for them.

RAISED in the BED // What

Square Roots Green Wall

Chef Salad Station

There is a fresh supply of unharvested greens at the front of the order line contained in Square Root container farm green wall.

Customers get to pick and harvest their chosen greens and bring them to the cart where a fresh salad is tossed for them.

RAISED in the BED // How

1. LEAF

1. A salad concierge helps participant learn about Square Root greens.
2. Participant leafs through the selection of greens from the living wall and and selects their salad base.

2. HARVEST

1. Participant harvests their leafy greens of choice from the wall with a lettuce knife.
2. Hands the fresh trimmed greens to the tosser.

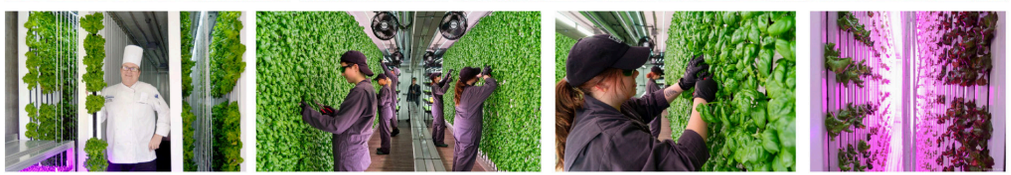
3. TOSS

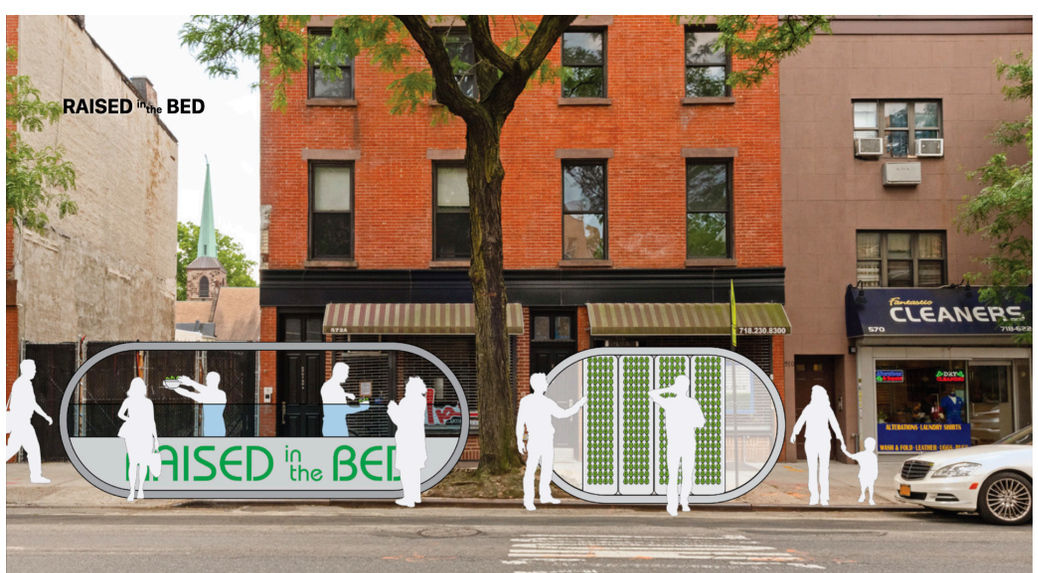
1. Greens are washed and chopped.
2. 3-5 toppings are chosen.
3. Light dressing applied.
4. Served in a bowl with a fork and a napkin.

4. TASTE

1. The participant enjoys a fresh salad with an unusually fresh taste.
2. Bowl and fork get dropped into 1 of two bins. (a) I can taste the freshness (b) if you say so.

RAISED in the BED // Square Roots @ Work





Utopia / Dystopia

Utopia

Humanity did the right things to handle their impact on climate change. We stopped the use of fossil fuels in favor of wind, solar, and waves. As a result, power has become abundant and free. DWP and the utility companies were absorbed by the global government, and electrical power is now considered a human right. Data followed suit. The internet and access to it is a global universal, additionally users privacy is now a protected resource. Sure, data-mining still happens, but now it occurs with explicit permission and government oversight to assure it is used for morally appropriate and humanity-benefiting reasons. The impact of this was pretty extraordinary; since no companies were focused on click-bait, marketing manipulation, etc., the internet has become a haven for sharing, connectivity, and data being used for the maximum benefit to its global users. Even agriculture and food production went through massive change. The maturing of the controlled environment Hyper-Farms facilitated an era of localized production of user specific produce development all within blocks of where people lived. This was able to scale large and small to sufficiently supply people whether they lived in vast rural spaces or dense urban areas. This even virtually eliminated food deserts (its true, they are still trying to perfect food supply with the randomness of personal travel, but they are getting pretty damn close). Cities have skyscrapers with a multitude of floors growing immense amounts of every type of fruit and vegetable you can imagine, robotic gardeners assure that each and every plant gets the love and attention it need, and its produce is picked exactly when the plant is ready. Lower floors handle any consumer handling requests: bundling into salads or mealkits, washing, chopping, and

processing into specific products or dishes, etc. These skyscraper hyper-farms can serve about a 20-block radius, so city skylines are now speckled with these towers of progress. A pleasant side effect is the air quality in cities is now as good if not occasionally better than rural environments. Speaking of rural, their Hyper-farms provide the same quality of automated produce production as the cities, but come in two different formats: the community center Hyper-farm exchanges and the Hyper-Solo. the community center Hyper-farm exchanges serves a small city or community and enables the citizens a place to congregate and socialize. The Hyper-Solo is a private version of the automated controlled environment agriculture farm which produces the produce for a single household.

The outcome of all of this bountiful controlled agriculture is that the valleys and plains which had previously been used as fields for crops were able to be re-wilded or turned into beautiful public lands and parks. Picture the areas around and between cities like a gargantuan scale park, like New York City's High Line. Towns across the country now take tremendous pride in the public parks and nature experiences which they manicure. Because of all of this refocusing on the natural world, plant, animal, and insect populations have blossomed and are working together as well nature intended, if not better.

One of my favorite parts of the new industrial/agriculture age that we are living in is the food. The Hyper-farms ushered in an era of healthy eating as well as an era of unbridled biodiversity in what foods were available. It started with reaching back into the seed vaults to establish

living examples of all of the historic produce which was once available in micro-moments of history and location. Soon after this, companies started bringing new hybrids and GMO plants into the world (BTW, GMO is a good thing now that the goal is to make things better for society and not to maximize profits.) This new culture of plants helped phase out pills and medicine, as plants could be specifically developed to help individuals prevent or treat specific ailments. Like Polio and the plague, diabetes, obesity, cancer, and heart disease are all diseases of the past. Following this era, citizens started using CRISPER technologies along with hybridization and the use of the highly customizable controlled environment agricultural processes to make new fruits and vegetables catering to specific tastes and eating enjoyment (taste, texture, skin thickness, etc.). It reminds me of the early American apple cloning heyday which introduced the world to the Golden Delicious, the Fuji, the Honey Crisp, and the Gala just to name a few. One of the coolest gifts people now give to one another is the fruit bonsai; a tiny plant growing one or two perfect fruits specifically developed for the delight of the recipient's taste.

What a cool world we live in. I can't wait to see what humanity does next.

Utopia / Dystopia

Dystopia

Humans have properly wrecked the earth. Poor farming practices littered inland waterways and oceans with nitrogen, phosphorous, and glyphosate, killing the plant and animal life in and along the rivers, and causing algae blooms along coasts so massive that they gobbled up the sea's oxygen supply and blocked the sun from piercing the thick layer of algae encasing everything. Global warming has shifted the modality of land use faster than humanity could shift farming practices.

The seas become as desolate as the land. Deserts both: one of dusty, nutrient-depleted soil and one of saline water. In its hubris, mankind didn't make a shift to the endless free supply of sunlight cascading to its surface by collecting abundant solar energy into power for civilizations, and the movements of the wind and the waves are wasted. Then we ran out of oil. The wellspring of technology, energy, power, and plastics screeched to a halt, but not before so much of the reserves in the pipelines and tankers were consumed in disbelief of the true end of the supply. Most of the industrial world assumed this was a ploy by the oil companies to synthetically manipulate the prices… their DeBeers diamond moment.

The failure of industrial infrastructure also brought down the global food supply. Gone are the days of grocery stores, frozen pizzas, and Ben and Jerry's ice cream. My strongest personal lament, though: bananas. As humanity worked to stabilize itself, we evolved back into a hunter gatherer society. Being post-industrial, the process changed a little. Sure we were hunting, but most of the prey to be had

Utopia / Dystopia

were rodentia and insects. Although wild-grown foods were scarce, gathering was for food as well as the raw materials of everyday life. My tribe was pretty creative and remastered the craft of material manipulation, so we were able to collect the core rewardable materials of metal, glass, and some plastics. Call us modern metal-smiths. As such, we became a valuable trade partner to many of the tribes living up and down the new Caribbean coast... You might remember it as Long Island.

What about farming good olde fruits and vegetables? Many tribes have scavenged seeds or saved from crops which they have grow in meager greenhouses. With energy and fresh water in such limited supply, it's hard to grow enough to share, but on a rare day a treasured piece of fruit or a few vegetables might come our way. Without a good way to grow, harvest, and transport them, they look pretty meager.. but beggars can't be choosers.

Harvesting Thoughts

These projects are just the beginning.

Growing healthy, sustainable food for the 9 billion people expected to be on the planet by 2050 requires rethinking and retooling humanity’s approach to agriculture.

To move forward, we need to bust the lingering myth that technology is the enemy of natural, abundant, and affordable food.

We need to embrace the bounty that technology can unlock for us. To reform our agricultural practices with location, resources, impacts, and opportunities all measured with an inclination for the best relationship with the plants which will sustain us and by learning and listening to what our bodies can reveal to us about how to properly nourish and maintain them for a happy healthy life.

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Key Terminology

CEA

An abbreviation of Controlled Environment Agriculture

Controlled-environment agriculture (CEA)

A technology-based approach toward food production. The aim of CEA is to provide protection and maintain optimal growing conditions throughout the development of the crop. Production takes place within an enclosed growing structure such as a greenhouse or building. Plants are often grown using hydroponic methods in order to supply the proper amounts of water and nutrients to the root zone. CEA optimizes the use of resources such as water, energy, space, capital and labor. CEA technologies include hydroponics, aeroponics, aquaculture, and aquaponics.

Different techniques are available for growing food in controlled environment agriculture. The more viable option is vertical farming. Vertical farming has the ability to produce crops all year round in a controlled environment, with the possibility of increased yield by adjusting the amount of carbon and nutrients the plants receive (Benke et al)[2]. In consideration to urban agriculture, controlled-environment agriculture can exist inside buildings that already exist, such as repurposed abandoned buildings.

Hydroponics

a method of growing plants in a water-based, nutrient-rich solution without soil.

Key Terminology

Hyper-farm

A modern, controlled-environment, agriculture-production facility.

These often utilize artificial lighting to manipulate the plants' different growing/flowering/fruiting cycles; synthetic control of the process of getting nutrients to the roots; and sensors and robotics to monitor the health and progress of the plants, as well as to aid in the harvesting process.

Root Train

A tool for the process of sequencing plants seeded/sprouted/cloned to enable a sample size to be ripening each week of the year to assure year round produce availability.

Related to the biology term seed train :: For the production of biopharmaceuticals a seed train is required to generate an adequate number of cells for inoculation of the production bioreactor. This seed train is time- and cost-intensive but offers potential for optimization. A method and a protocol are described for the seed train mapping, directed modeling without major effort, and its optimization regarding selected optimization criteria such as optimal points in time for cell passaging.