Grow

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Contents

Statement of Intent

Upon the current waste crisis, designers are approaching bio-design through renewable and naturally compostable materials which can be easily grown; such as mycelium, bacterial cellulose and plant fibers.

However, plastic production and the use of non compostable polymers continues to rise globally.
The film aims to:

i. Portray the existence of matter, plants, bacteria and human beings in an equal plane and temporality.

The workbook aims to:

i. Envision economic, social and environmental opportunities for Costa Rica which can be explored through bio-technology, bio-design and the production of these organisms.
ii. Identify strategies and projects from around the World in which bio-technology and bio-design are driving bio-economies and research for alternative materials through art and design.

In response to this, the following areas present opportunities for further research and development:

i. Understand the way in which organisms such as mycelium, bacterial cellulose and plants grow.
ii. Explore the benefits and limitations of using these organisms in applications such as art, packaging, fashion and design.
iii. Develop social experiments and products to study the acceptance of these materials among potential consumers.

Introduction - Jumping to Conclusions

The Plastic Age - Life during the Waste Crisis

Humanity is currently undergoing a critical waste crisis which is clearly affecting us as a species; along with the wildlife and organisms which our planet supports.

This reality, however is roughly over one century[1] old, and can be linked directly to the creation and popularization of plastic. Our reliance on polymers has led historians, scientists and writers to call our era the Plastic Age.[2]

According to Peter Rem, associate professor of resources and recycling at the Delft University of Technology, 40% of all plastics produced globally are used for packaging.[3] The majority of our plastic packaging is used only once before being disposed, making most of our packaging actually last longer than the products they were designed to 'protect'.[4] To top this off, improper disposal of such material generally results in this 'waste' washing out into the oceans.[5]

Approximately 275 million tons of plastic waste are generated each year around the world; of which an estimated 4.8 million to 12.7 million tons eventually end in the oceans. Even with such alarming numbers, the industry is expected to produce three times as much plastic in the next 30 years. It is foreseen by the World Economic Forum (WEF) "that by 2050 there will be more plastic than fish in the world's oceans".[6]

1 "Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016". Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 4

2 Richard C. Thompson, Shanna H. Swan, Charles J. Moore and Frederick S. vom Saal, July 27, 2009, https://royalsocietypublishing.org/doi/10.1098/rstb.2009.0054

3 "SPCEx_Module_2_2-2-1_Recycling_Plastic_Packaging-video", YouTube Video, 0:34, posted by "SPCEx Sustainable Packaging in a Circular Economy", Nov 7, 2018, https://www.youtube.com/watch?v=p%20Yin7jnWos&feature=youtu.be

4 Michael Braunggart and William McDonough, Cradle to Cradle (London, Vintage Books 2009), 18

5 "New Plastics Economy Animation - Innovation Prize", YouTube Video, 0:06, posted by "Ellen MacArthur Foundation", Feb 26, 2018, https://www.youtube.com/watch?v=hukBdiuIdDU

6 "Plastic Oceans", FutureAgenda.org, accessed November 29, 2019, https://www.futureagenda.org/wp-content/uploads/2018/12/FA-Book-Insights-Plastic-oceans.pdf

A Systematic Trap from Revolution to Revolution

The current production model that humanity has been following during the past decades fits into the "cradle to grave" scenario, in which products are basically developed from natural resources and raw materials to live a pre-defined life span; and eventually become useless, outdated or obsolete.[7] These obsolete products end up in (best case scenario) landfills or are disposed directly into the environment as waste. Some efforts such as recycling, up cycling and reusing have tried to reduce the effect of mainstream consumerism. However these efforts are faced with far too many complications which push them away from becoming sustainable solutions.

We have dragged the consumerist / economic production model along since the Industrial Revolution, and, as the Industrial Revolution itself, we have continued to burden our societies and the environment in order to reach unsustainable economic goals.[8]

As Naomi Klein states: "Our economy is at war with many forms of life on Earth, including human life."[9] Our lack of environmental vision is rapidly stripping the planet of its limited natural resources. We are finding ourselves limiting what once was though to be unlimited and polluting what is vital for survival; while leaving in return hazardous materials that are not biologically safe and that require extreme conditions to biodegrade and compost. This apocalyptical scenery seems to benefit a selected few who thrive at the cost of the many - but - does it really have to be this way?

7 Michael Braunggart and William McDonough, Cradle to Cradle (London, Vintage Books 2009), 27

8 Michael Braunggart and William McDonough, Cradle to Cradle (London, Vintage Books 2009), 18

9 Naomi Klein, "This Changes Everything" (Simon & Schuster 2014), 21

The Material Enigma

As usual, there seems to be a light at the end of the tunnel; a certain promise of salvation from our own greed, and alternatives to continue managing the unmanageable. Some confusing and yet simple to understand concepts have surged and now appear to interfere with consumer decisions.

Wording such as 'petrochemical' or 'fossil based' are being antagonized by words such as 'bio-based', 'biodegradable', 'compostable' and 'renewable'[10] which may sound like promising, friendlier and healthier options for our manic consumption of materials. But what do each of these actually mean? The faster we understand these words, the better we will be along the road, and the less we will be fooled by 'greenwashing' campaigns.

Petrochemical / fossil based plastics are developed out of fossil feedstocks and natural gas. This raw material has taken millions of years to form. Some of these plastics are polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polystyrene (PS).[11]

Bio-based products are created from bio-mass. Biomass is material from biological origin, excluding material sourced from geological formations or fossils. Some examples of bio based materials are wood or paper, but polymers derived from sugars such as PLA are also bio based products.[12]

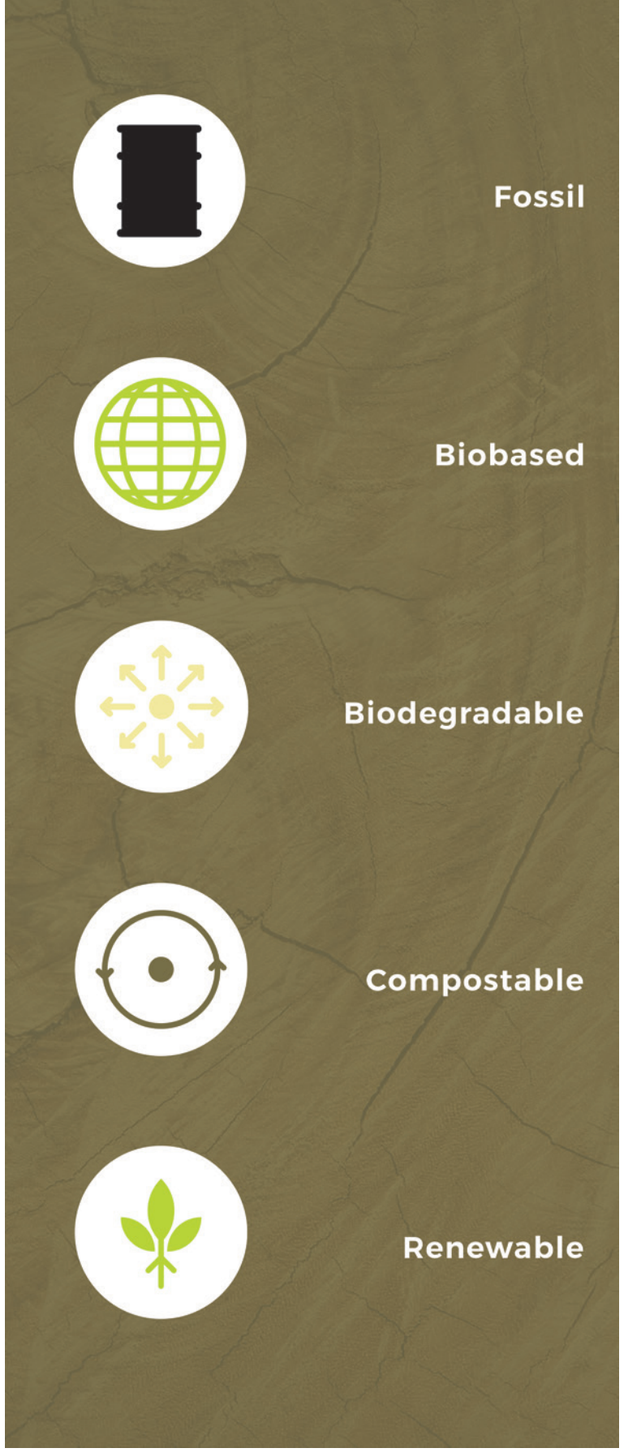


Fig. 1
Undestanding Materials
(D. Miranda 2019)

Biodegradable materials can be broken down by microorganisms such as bacteria or fungi into water, carbon dioxide, methane or biomass. Biodegradability depends on environmental conditions (temperature, humidity, oxygen); therefore biodegradability and degradation rate of each material will vary in different environments and scenarios.[13]

Compostable materials break down naturally at composting conditions which can be either:
Industrial composting conditions: Require elevated temperatures (55-60˚C) with high humidity and oxygen.
Home composting conditions: Rely on lower temperatures and therefore occur in much slower degradation rates (depending on the material).
Compostability is subject to time of decomposition and wether reabsorption of elements and molecules into the biosphere happens naturally and successfully.[14]

Renewables are materials that come from resources that can be naturally produced and replenished within a human timeframe (opposite to fossil fuels which take millions of years to be produced). Bio-based raw material can be also called renewable if its cultivation balances harvesting. For example teak wood may be considered a renewable source while tropical hardwood may not keep up with logging activity.[15]

Understanding these terms is important to envision the future of materials. The past two centuries have been remarkably important for the development of synthetic chemistry, which now provides the working platform for developments in bio-technology to explore new sustainable materials and alternatives which lead to innovating and expanding a new bio-economy.[16]

10 Martien van den Oever, Karin Molenveld, Maarten van der Zee, Harriëtte Bos, Bio-based and biodegradable plastics – Facts and Figures (Wageningen Food & Biobased Research 2017), 15

11 Martien van den Oever, Karin Molenveld, Maarten van der Zee, Harriëtte Bos, Bio-based and biodegradable plastics – Facts and Figures (Wageningen Food & Biobased Research 2017), 16

12 Martien van den Oever, Karin Molenveld, Maarten van der Zee, Harriëtte Bos, Bio-based and biodegradable plastics – Facts and Figures (Wageningen Food & Biobased Research 2017), 15

13 Martien van den Oever, Karin Molenveld, Maarten van der Zee, Harriëtte Bos, Bio-based and biodegradable plastics – Facts and Figures (Wageningen Food & Biobased Research 2017), 16

14 Martien van den Oever, Karin Molenveld, Maarten van der Zee, Harriëtte Bos, Bio-based and biodegradable plastics – Facts and Figures (Wageningen Food & Biobased Research 2017), 16

15 Martien van den Oever, Karin Molenveld, Maarten van der Zee, Harriëtte Bos, Bio-based and biodegradable plastics – Facts and Figures (Wageningen Food & Biobased Research 2017), 15

16 "Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016", Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 4

“Innovations that are guided by smallholder farmers, adapted to local circumstances, and sustainable for the economy and environment will be necessary to ensure (food) security in the future.”

Bill Gates

Part I - Bio-development in developed countries and the opportunities for developing countries

The globalization of bio-technologies, bio-design and bio-economies

The UK is aiming to reach a £10bn market in synthetic biology by 2030. This vision has led to the investment and promotion of research and development among various organizations, universities and the industry. As a result, a great amount of startups, businesses and SMGs have emerged to explore the potential of applications using synthetic biology.[17]

The Synthetic Biology Leadership Council (SBLC) has developed a strategic plan to approach this future economical landscape on a grounded basis which can provide a functional model to follow around the World. How could this model be exported to Costa Rica?

This model presents 5 fundamental suggestions in order to plan the way forward to a thriving bio-economy:

1. Accelerate industrialization and commercialization by promoting investment in, and industrialization of, empowering bio-design technologies and assets to drive economic growth.[18]

2. Maximize the capability of the innovation pipeline by continuing to research and develop platform technologies that will improve manufacturing efficiencies and unlock future opportunities.[19]

17 “Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016”, Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 2

18 “Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016”, Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 13

19 “Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016”, Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 16

3. Build an expert workforce by developing the skills required for bio-design and implementing them through education and training.[20]

4. Develop a supportive business environment by ensuring that regulation and governance systems are proportionate and appropriate to the needs of industry and that these are aligned with the needs and desires of stakeholders.[21]

5. Build value from national and international partnerships by fully integrating the UK synthetic biology community to position UK research, industry and policy makers as partners of choice for international collaboration.[22]

The potential of bio-materials entangles not only economical opportunities but also environmental solutions and alternative social development strategies that could be promoted in Costa Rica. With a stable tropical climate that averages yearly between 13˚C (Highlands) 22˚C (Central Valley) and 27˚C (Lowlands); and relative humidity that averages between 70-90% yearly[23], Costa Rica has based its economy on the production and export of biological products such as coffee, banana, pineapple and flowers. This has already proven a positive production platform from which to emerge with modern bio-technologies.

According to Doing Business, Costa Rica is ranked above the regional average (Latin America & Caribbean) as an economy to start a business.[24] High education levels, professional outcomes and political stability have led large corporations such as Intel and Amazon to develop HQ operations in the Central American country.

20 "Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016", Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 18

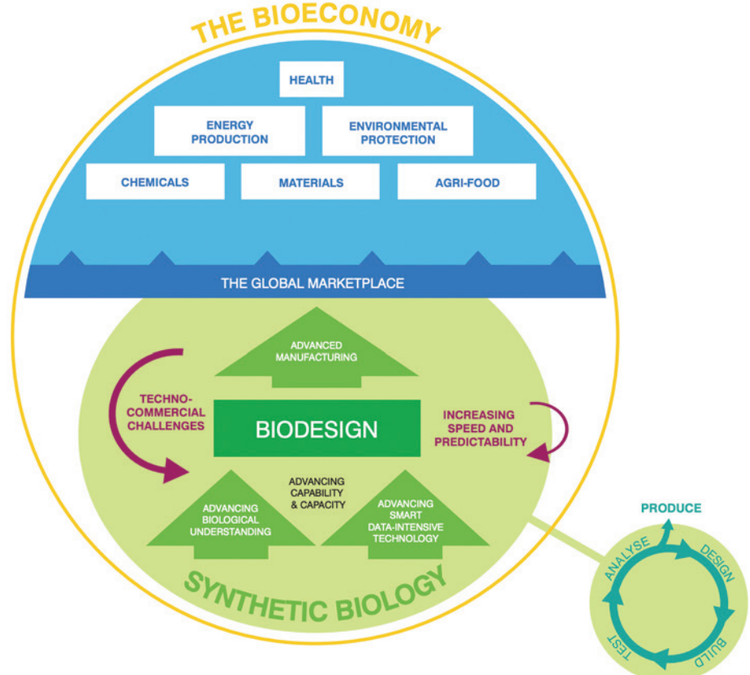
21 "Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016", Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 22

22 "Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016", Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 25

23 Instituto Metereológico de Costa Rica, accessed January 25, 2020, https://www.imn.ac.cr/inicio

24 "Doing Business 2020 - Costa Rica", DoingBusiness.org, accessed January 26, 2020, https://www.doingbusiness.org/content/dam/doingBusiness/country/c/costa-rica/CRI.pdf, 6

Fig. 2
The evolution of Synthetic Biology (SBLC, 2016)



Roughly 100 DIYBio Communities have registered around the Globe, mostly in the US and Europe, with only a few in Latin America and none in Costa Rica.[25]

Could Costa Rica become a partner for the UK and the US in the Development of bio-technologies and bio-materials? How could a shift towards bio-economies benefit the local economy and environment? What role would bio-design play in positioning Costa Rica within the new developing bio-economies?

25 Do it Yourself Bio, accessed January 25, 2020, https://diybio.org/local/

Part II - Growing Opportunities in Costa Rica

The Problem / Solution Paradox - Drinking the ‘half empty’ / ‘half full’ cup

Opportunities often come disguised as problems, but sometimes problems arise disguised as solutions. What is important is to recognize and embrace the openness of new ideas that may represent new economies and more sustainable paths.

Can the growth and use of bio based - compostable materials such as mycelium, bacterial cellulose and plant fibers generate economic, environmental and social opportunities?

In this next section I will identify three categorical situations (some disguised as solutions, and some disguised as problems) which are currently happening (2018-2021) in Costa Rica. I have classified these situations as ‘economical’, ‘environmental’ and ‘social’. These situations may represent growing opportunities.

A wide open Economy

As part of its Decarbonization Plan, the Government of Costa Rica has announced the commitment to become a “modern, green, emission-free, resilient and inclusive economy”.[26] The Government has set the ambitious goal of becoming the first carbon neutral country in the world by 2021.

Off with a good starting point, Costa Rica is not new to ‘Green Economies’. In the past decades, the country has made great

26 “Plan de Descarbonización”. Ministerio de Ambiente y Energía, accessed December 1, 2019. https://minae.go.cr/images/pdf/Plan-de-Descarbonizacion-1.pdf, 3

advances towards sustainability including an operational electrical grid which relies 95% on renewable sources such as hydro, geothermal, solar and wind power; and diminishing its deforestation rate towards an actual reforestation process that has resulted in 52% of the national territory developing or protected as forestal coverage.[27]

One of the most remarkable actions that have been taken so far is part of the Integral Waste Management axis of the Decarbonization Plan, and was legislated on July 15th, 2019, under the Law 9703. This act consists on the prohibition of import, commercialization and delivery of containers and recipients made out of expanded polystyrene (EPS), also known as styrofoam.[28] This first initiative is to be followed by a ban on single use plastics by 2021.

The law gives a 24 month period for local commerce to adapt to and become resilient to the new measurements. However, there are some loopholes, as it only refers to banning the products in which styrofoam is the actual 'end product' such as food containers, coolers and cups; this means that other products such as home appliances (refrigerators, televisions, microwave ovens) which use styrofoam as a protective packaging material will still be allowed to be imported.[29]

This initiative was widely welcomed by the general population. This general view may be entangled with a rising awareness regarding waste management throughout the country. There has been a massive increment of 469% in recycling practices amongst the population in only 2 years (between 2015-2017). The numbers show a total of 100,200 tons of residue recovered for recycling on 2017, against 40,000 tons registered on 2016, and 17,200 tons recovered on 2015.[30]

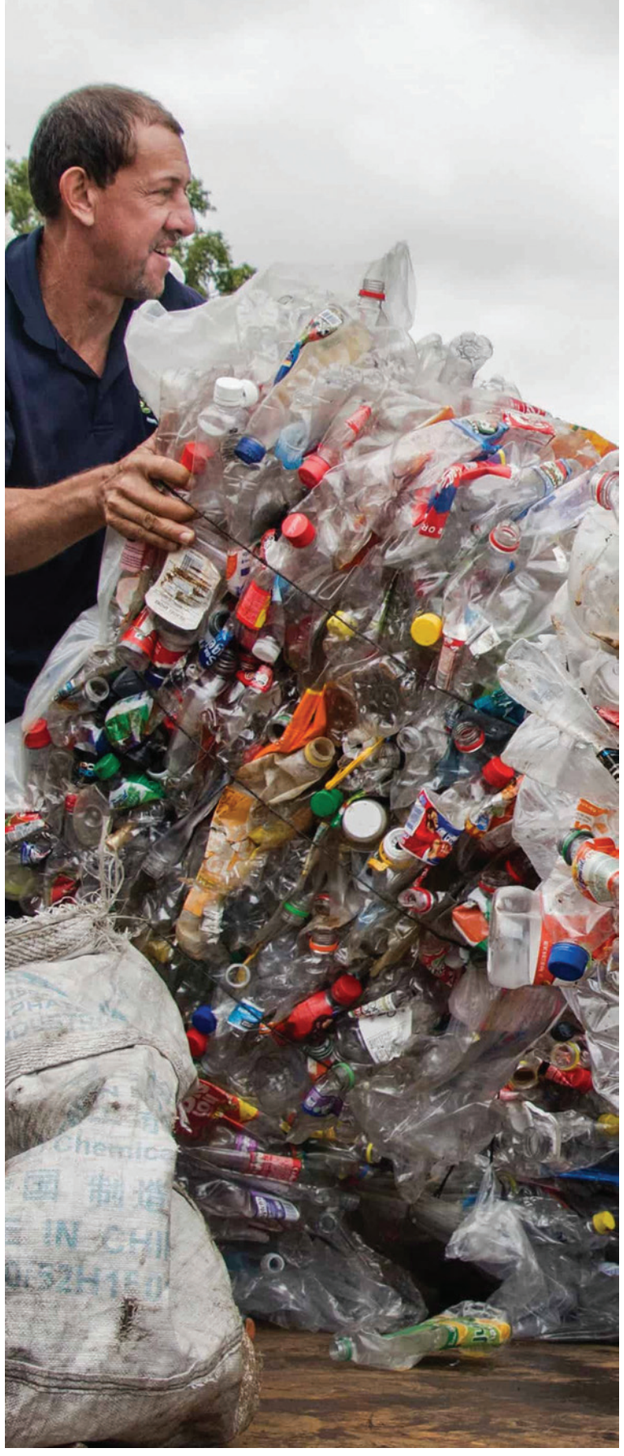


Fig. 3
Recycling in Costa Rica (E.Becerra, 2018)

However on another perspective, this increment on recollection of recyclable material may actually be a reflection of an increment of plastic production and consumption. According to the United Nations Procurement Division (UNPD), plastic represents the 3rd largest industry in Costa Rica, and additional to that "we (Costa Rica) are the largest importer of plastics in Central America"; according to Juan Carlos Piñar, representative of UNPD - Costa Rica.[31]

According to UNPD, Costa Rica is currently disposing of 550 tons of plastic, daily; of which 80% (440 tons) is disposed into the ocean, 11% (60,5 tons) is sent to landfills or remains in the environment, and only 9% (49,5 tons) is recycled.[32]

The intentions of leading Costa Rica towards a plastic free economy are very positive, however there seems to be a toxic dependency on these materials amongst the population, commerce and the industry within the region.

Is this dependency an opportunity to develop alternative, green, and sustainable businesses in the country and Central American region? Are we looking into a wide open possibility of development and introduction of new technologies that rely on bio-based, compostable materials to satisfy the constantly increasing demand of the packaging industries? How may this represent an economic opportunity for the production of the previously mentioned organisms?

27 "Plan de Descarbonización", Ministerio de Ambiente y Energía, accessed December 1, 2019, https://minae.go.cr/images/pdf/Plan-de-Descarbonizacion-1.pdf, 3

28 Lucía Astorga, "Firmada Ley que prohíbe el estereofón en Costa Rica", La Nación, July 15, 2019, Accessed on December 1, 2019, https://www.nacion.com/ciencia/medio-ambiente/firmada-ley-que-prohibe-el-estereofon-e-costa-rica/KZP7B5WUT5FUZCWH74LJEW7SZ4/story/

29 Lucía Astorga, "Firmada Ley que prohíbe el estereofón en Costa Rica", La Nación, July 15, 2019, Accessed on December 1, 2019, https://www.nacion.com/ciencia/medio-ambiente/firmada-ley-que-prohibe-el-estereofon-e-costa-rica/KZP7B5WUT5FUZCWH74LJEW7SZ4/story/

30 Diego Bosque, "Reciclaje en Costa Rica aumenta 469% en solo dos años", Amelia Rueda, October 30, 2019, Accessed on December 1, 2019, https://www.ameliarueda.com/nota/reciclaje-aumento-un-469-en-solo-dos-anos

31 Irina Grajales Navarrete, "Costa Rica tira al mar 15 camiones de plástico por día", Hoy en el TEC, June 5, 2018, Accessed on December 1, 2019, https://www.tec.ac.cr/hoy-eneltec/2018/06/05/costa-rica-tira-mar-15-camiones-plastico-dia

32 "UNDP.org", accessed November 29, 2019, http://www.cr.undp.org/content/costarica/es/home.html

A Double Faced Agenda - Pineapple and Shrimp in the 'greenest and happiest' country in the World

During the past years various heated debates have been making headlines on the local news in Costa Rica. On one hand, the unmeasured expansion of pineapple plantations has been invading some of the country's protected areas and resulting in disastrous consequences towards the population and natural resources; and on the other hand, a strong intention of reviving shrimp trawling is being disputed between legislators, fishermen and environmentalists.

November 2019 became the scenario of a critical tipping point, as two unprecedented blows to the country's 'green image' were brought to the light. First the grant by the National Technical Secretariat for the Environment (SETENA) to reactivate viability of a pineapple expansion project; and second, the voted approval of reactivating shrimp trawling by the Legislative Assembly.

Pineapple - Death wears a Crown

According to the Food and Agriculture Organization of the United Nations (FAO) Costa Rica leads the world's pineapple production. In 2017 Costa Rica accounted for the production of an estimated 3.1 million tons of pineapple, placing itself above the Philippines (2.7 million tons) and Brazil (2.3 million tons).[33]

Fig. 4
Pineapple in Costa Rica (D.Miranda, 2018)

Not surprisingly, Costa Rica also leads the world's agrochemical consumption (per hectare) using, according to the Regional Institute for Studies in Toxic Substances (IRET) of the National University of Costa Rica (UNA), 18.2 kilograms of agrochemicals per hectare. Second to Costa Rica is China which consumes 17 kilograms per hectare and the United States of America follows with 2.5 kilograms per hectare. Pineapple production practices recommend the use of as much as 20 kilograms of agrochemicals per hectare.[34]

Two US-based multinationals, Del Monte and Dole, control the local production, and thanks to intensive agroindustrial practices the monoculture of pineapple has become a thriving business in the global market: 3 out of 4 pineapples sold in the European market come from Costa Rica. The dark truth behind the prosperity of pineapple production is the reliance on various toxic agrochemicals, many of which are legal to use in Costa Rica, but have been banned in Europe, the United Kingdom and the United States of America.[35]

The use of agrochemicals for pineapple production has taken its toll on the population and the environment. Dozens of reports, such as the one interposed by the Ministry of Environment on 2018, have evidenced the death of wildlife along marshes, wetlands and rivers linked to the excessive use of toxic substances.[36] Reports and studies dating as far as 2003 evidenced the presence of Bromacil on the water supply of various communities and most recently, on August 2019, a group of 16 children and 6 adults had to be hospitalized due to intoxication after the school they were inhabiting was contaminated through fumigation with toxic agrochemicals by a neighboring pineapple plantation.[37]

33 "Pineapple production in 2016, Crops/Regions/World list/Production Quantity (pick lists)". UN Food and Agriculture Organization, Corporate Statistical Database (FAOSTAT). 2017. Accessed Dec 1, 2019.

34 Lindsay Fendt, "Costa Rica consumes more agrochemicals per hectare than any country in the world", The Tico Times, June 7, 2015, Accessed on December 1, 2019, https://ticotimes.net/2015/06/07/costa-rica-consumes-agrochemicals-per-hectare-country-world?fbclid=IwAR1honTdjLrKhBGAr-XAC6hEUEF_zVByZm3Mfvzjo5lUmdENwBFXpAy3Go4

35 Felicity Lawrence, "Bitter fruit: The truth about supermarket pineapple", The Guardian, October 2, 2010, Accessed on December 1, 2019, https://www.theguardian.com/business/2010/oct/02/truth-about-pineapple-production

36 Manuel Sancho, "Minae presentó denuncias por contaminación de ríos en Limón", CRHoy, May 28, 2018, Accessed on December 1, 2019, https://www.crhoy.com/ambiente/minae-presento-denuncia-por-contaminacion-de-rios-en-limon/

37 Beatriz Sanchez, "Deuda piñera: Costa Rica continúa sin medir impacto en la salud de las comunidades contaminadas", Delfino, November 21, 2019, Accessed on December 1, 2019, https://delfino.cr/2019/11/deuda-pinera-costa-rica-continua-sin-medir-impacto-en-la-salud-de-las-comunidades-contaminadas

One would believe that such a thriving industry would represent positive economical affluence to the country, however the reality is quite the opposite. This year, the Federation for Nature Conservation (FECON) denounced that the Estates Ministry exonerated pineapple industries from the payment of between ¢2.250 and ¢6.000 million (£3,103,238.25 to £8,275,302.00); which basically consists of a discount of 60%-80% of the debt these enterprises held to the country.[38]

Many of the country's pineapple companies have also been reported for their abusive labour practices and very denigrating conditions in which the workers find themselves. The majority (60%) of the workers are Nicaraguan, and most live under illegal immigration status; and therefore are undermined to the country's protective Work Code. This means that they are not necessarily paid the minimum wages and the company is exempt from covering social services established by the Costa Rican legislation to all legal workers. Workers are also exposed repeatedly to the toxic chemicals that the industry utilizes and as some workers report "They spray us with chemicals, but they don't offer us appropriate medical care when we get ill. They don't care if workers get poisoned."[39]

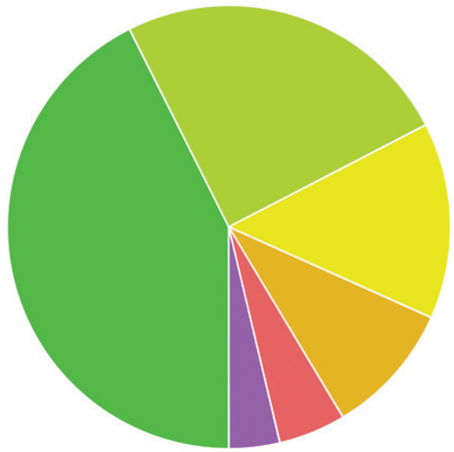
Fig. 5
Pineapple
Monocultive
(D.Miranda 2018)

38 Yamileth Angulo, "Amnistía fiscal le perdona a empresas piñeras entre ¢2.250 y ¢6.000 millones, denuncia Fecon", El Mundo CR, May 2, 2019, Accessed on December 1, 2019, https://www.elmundo.cr/costa-rica/amnistia-fiscal-le-perdona-a-empresas-pineras-entre-%C2%A22-250-y-%C2%A26-000-millones-denuncia-fecon/?fbclid=IwAR3udLCXhWgyOActjGFL9bDN-wPU57IUf55schNPFzRHdZdoK4v25XIIRIx8

39 "Sweet fruit, bitter truth", Oxfam, accessed December 1, 2019, https://www.oxfam.de/system/files/20160531-oxfam-sweet-fruit-bitter-truth-en.pdf, 9

According to the 2016 report by Oxfam Germany, the pineapple business is shared as follows:

Fig.6
Pineapple
Revenue
(D.Miranda 2019)



- **42.6% | Retailers**
- **24.8% | Producers**
- **14.3% | Importers and transport companies**
- **9.7% | Workers' wages**
- **4.9% | Exporters**
- **3.7% | Customs**

After revisiting the country in 2019, Oxfam Germany concluded that not much had changed since its initial report.[40]

The local population manifested its concern after learning that National Technical Secretariat for Environment (SETENA) granted environmental permits to a project that plans on exploiting 494.5 hectares of land destined to the production of pineapple in the Osa Peninsula.[41] Fortunately, after heated debates and a general rejection from the public made its way to the media and social networks, the Ministry of Environment dismissed and buried any viability for the project.[42]

40 "Sweet fruit, bitter truth", Oxfam, accessed December 1, 2019, https://www.oxfam.de/system/files/20160531-oxfam-sweet-fruit-bitter-truth-en.pdf, 13

41 Andrea Mora, "Resolución de Setena revive discusión sobre proyecto piñero en cercanías de Humedal Térraba-Sierpe", Delfino, November 27, 2019, Accessed on December 1, 2019, https://delfino.cr/2019/11/resolucion-de-setena-revive-discusion-sobre-proyecto-pinero-en-cercanias-de-humedal-terraba-sierpe

42 Andrea Mora, "MINAE retira viabilidad ambiental a proyecto piñero en las cercanías del humedal Térraba-Sierpe", Delfino, December 19, 2019, Accessed on December 25, 2019, https://delfino.cr/2019/12/minae-retira-viabilidad-ambiental-a-proyecto-pinero-en-las-cercanias-del-humedal-terraba-sierpe

This project became the center of discussion mainly because the targeted location is located only a couple of kilometers away from one of the most important archaeological sites in Costa Rica. The Diquís Delta in Sierpe is home to the unique, mysteriously enigmatic and internationally known stone spheres of Costa Rica. These stones represent invaluable cultural heritage of the country's pre-columbian history, reason for which the site was declared World Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2014.[43]

The creation and use of these stone spheres dates back to 400-500 D.C. up to the Spanish conquest. They were handcrafted locally by the natives using materials such as rock and wood, under technological and social circumstances that are considered extremely difficult now days. The spheres vary in size and weight, with the larger spheres weighing over 1 ton. The largest known sphere measures an impressive 2.6 meters in diameter and weighs over 26 tons. Over 56 archeological sites have registered the presence of the mysterious stone spheres.[44]

This site and its surroundings had already been affected by the banana plantation expansion during the 1940s, when hundreds of hectares of primary rainforest were destroyed in order to yield the space to monoculture. During this time over 200 stone spheres that were discovered on the site were extracted without any jurisdiction or any analytical registrations, losing all information on the specific positioning of the mysterious legacy of the natives. Only 6 stones remain in their original locations. These stones are aligned with the sun and seem to map certain astronomical events. [45]

Fig.7
Stone Spheres in Costa Rica (D.Miranda 2018)

Other than an unmeasurable archeological value, the property which would have been used to grow pineapple neighbors the Térraba - Sierpe National Wetland, is an environmentally unique territory. This wetland was valued by the International Center of Economical Politics for Sustainable Development of the National University of Costa Rica (CINPE-UNA) for its eco systematic services at an average of $17,084 per hectare per year, adding up to an average of over $380,000,000 per year; resulting crucially beneficial to the neighboring communities and the rest of the country.[46]

The creation of such industry would have also affected the communities which are located only 500 meters away from the property in dispute. These communities and their inhabitants rely on the archeological and ecological value of these lands and are economically sustained by archaeo- and eco- tourism, and its preservation.

The Conservationist Federation of Costa Rica (FECON) has recently reported that the invasion of pineapple fields in Protected Areas and wetlands has increased in over 300%.[47]

The pineapple industry is not likely to recede from Costa Rica. However, new ideas and projections may be proposed especially to make use of the agricultural waste of the industry such as the leaves which contain valuable fibers which can be repurposed into commercially viable bio-materials.

43 Ifigenia Quintanilla, "El diquís, las esferas de piedra y su valor cultural universal", Ifigenia Quintanilla, June 23, 2016, Accessed on December 1, 2019, https://ifigeniaquintanilla.com/2016/06/23/el-diquis-las-esferas-de-piedra-y-su-valor-cultural-universal/

44 Ifigenia Quintanilla, "El diquís, las esferas de piedra y su valor cultural universal", Ifigenia Quintanilla, June 23, 2016, Accessed on December 1, 2019, https://ifigeniaquintanilla.com/2016/06/23/el-diquis-las-esferas-de-piedra-y-su-valor-cultural-universal/

45 Ifigenia Quintanilla, "El diquís, las esferas de piedra y su valor cultural universal", Ifigenia Quintanilla, June 23, 2016, Accessed on December 1, 2019, https://ifigeniaquintanilla.com/2016/06/23/el-diquis-las-esferas-de-piedra-y-su-valor-cultural-universal/

46 Redacción, "Clamor general y pruebas abundantes: «Debe revocarse la resolución de Setena»", Cultura CR Net, November 26, 2019, Accessed on December 1, 2019, https://www.culturacr.net/clamor-general-y-pruebas-abundantes-debe-revocarse-la-resolucion-de-setena/

47 Yamileth Angulo, "Fecon denuncia que invasiones de piñeras en Áreas Silvestres Protegidas y humedales aumentan 300%", El Mundo CR, November 13, 2019, Accessed on December 2, 2019, https://www.elmundo.cr/costa-rica/fecon-denuncia-que-invasiones-de-pineras-en-areas-silvestres-protegidas-y-humedales-aumentan-300/?fbclid=IwAR3CUEEuroR-9moV52tzTkT4cQq_gE7MY32hrJoQV4nOkB6xKEZpZVHVK7Qg

Shrimp - Swimming against the tide

Trawling is a fishing practice that consists on dragging weighted nets across the sea floor (bottom) or mid water. This practice is commonly used to catch shrimp, tuna, anchovies and mackerel (midwater); and cod, halibut and rockfish (bottom). However, the practice it is known for its lack of selectiveness and results in sweeping both commercial and non-commercial organisms, disregarding size or species. Any species other than the desired catch is considered by-catch and is discarded.

Most of the by-catch is either killed due to the trawling process or dies when unloaded into the fishing vessels. By-catch may include valued species such as sharks, manta-rays, sea turtles, whales and dolphins. According to recent studies by the University of Costa Rica (UCR) for every 1 kilogram of shrimp, 5 kilograms of by-catch are discarded, and as the The Center for Science Research Sea and Limnology (CIMAR) states, there is no evidence of the sustainability of this practice.[48]

On 2013 the Constitutional Hall prohibited the Government from issuing new licenses for trawling fisheries, after concluding that the practice was environmentally destructive. Later, on 2018 the same entity stated that new licenses for shrimp trawling would only be considered if "techno-environmental studies determined the viability of sustainable trawling".[49]

The Costa Rican Institute of Fishing and Aquaculture (INCOPESCA) generated a controversial study claiming the sustainable opportunities in shrimp trawling. This report was strongly criticized by the scientific community, academics, conservation entities and organizations such as MarViva, labeling the report as "lacking seriousness". Nonetheless, on

Fig.7
Shrimp
Bycatch
(Marviva, 2019)

November 26, 2019, the project that is looking to reactivate shrimp trawling was approved by the deputies of the Legislative Assembly, receiving 26 votes in favor and 18 votes against it during its first debate. The project is to allow INCOPESCA to continue the 'viability study' during a year, expecting to have the final results within a year to begin issuing commercial licenses to the fisheries.[50]

This study however does not consider the artisan fishermen who rely on more sustainable fishing practices. Several syndicates of fishermen claim that the actors who are pushing this new deal are "taking advantage of the 'hunger' that Puntarenas suffers"; also claiming that several politicians are using this opportunity to win new votes for the upcoming municipal elections.[51]

It is not surprising for poverty, unemployment and hunger to be a critical factor drawing the project. A swopping 12% unemployment rate is dreading the country. The increasing cost of life is affecting low income families along with the working class, resulting in 20.7% of the population living in poverty, according to reports dated on 2018.[52]

The economic and human capital of fishing practices have always led the discursive 'value' of such industries. However, new economic models based on bio-materials could present economical and social alternatives for these economically marginalized communities.

48 Management UCR, "Cimar-UCR decides on trawling", Universidad de Costa Rica, November 17, 2019, Accessed on December 2, 2019, https://www.ucr.ac.cr/noticias/2017/11/17/el-cimar-ucr-se-pronuncia-sobre-la-pesca-de-arrastre.html

49 Federación Ecologista Costarricense, "Costa Rica: La pesca de arrastre sostenible no existe", El País CR, November 26, 2019, Accessed on December 2, 2019, https://www.elpais.cr/2019/11/26/costa-rica-la-pesca-de-arrastre-sostenible-no-existe/

50 Dinia Vargas, "Diputados aprueban proyecto que revive pesca de arrastre de camarón", Amelia Rueda, November 27, 2019, Accessed on December 2, 2019, https://www.ameliarueda.com/nota/diputados-aprueban-proyecto-revive-pesca-arrastre-camaron?fbclid=IwAR1pxsw2BHnS1rs8UlNp3bZ7ZH2ivm6FvnEXvtkLz1x4G5s8g63rHO2twMk

51 Yamlek Mojica, ""Se quieren aprovechar del hambre de Puntarenas", afirman colectivos contra pesca de arrastre", Amelia Rueda, November 27, 2019, Accessed on December 2, 2019, https://www.ameliarueda.com/nota/se-quieren-aprovechar-del-hambre-de-puntarenas-pesca-de-arrastre

52 UNPD, "Costa Rica en Breve", UNPD.org, Accessed on December 2, 2019, https://www.cr.undp.org/content/costarica/es/home/countryinfo/

Such is Life in the Tropics

Looking into the currently threatening and environmentally destructive activities such as pineapple production and shrimp trawling, one must consider: Is the economic value larger than the environmental loss? Does the human and wildlife capital in dispute really benefit from these practices or is it only profitable for the corporate businesses and politicians behind these projects? How would the creation of new environmentally safe bio-industries benefit the human and nonhuman inhabitants of these communities?

Growing hope in social decay - Social reinsertion of recovering addicts

As previously mentioned, poverty is currently striking the marginal communities of Costa Rica. A vicious circle between a tumbling economy, declining public (and sexual) education and limited work opportunities for the marginalized and under educated; results in many young men and women stepping into the dreadful world of narcotics.

Costa Rica is located in a crucial midpoint between South America and North America; and separates the Pacific Ocean and Caribbean Sea. This location has shaped its geographical wonders and has blessed the country with biodiversity and cultural richness; but currently this location is an asset for drug trafficking between the southern and northern regions of the American Continent.

The Alcoholism and Drug dependance Institute currently provides clinical attention to 22,471 persons with social, psychological and/or medical disorders related to drug abuse.

Fig.8
Homeless Boys
Costa Rica
(D.Dosdall, 2006)

The attention provided to these persons could be affected by a new cut in the budget destined to the Institute by the Tobacco Law.[53]

Currently 10% of the resources generated through the 9028 (Tobacco) Law are destined to the Institute to provide attention to thousands of children, teenagers and adults in vulnerable status. Recently, a project intends to reform this law and lower the budget to 5%. This would also affect other 1,149,502 persons who are beneficiaries of the institute's drug prevention programs.[54]

With a growing index of drug related crime, and an alarming number of drug related homicides and violence, civilian safety has diminished in Costa Rica and is now affecting economically important sectors such as the tourism industry. According to the World Top 20 Project, Costa Rica is currently ranked 23rd in Crime Rate statistics.[55] Cheap prices of highly addictive drugs such as crack, cocaine and alcohol, have resulted in a growing number of homeless persons that prowl the city streets.

According to studies, less than 25% of crack addicts remain sober after given treatment, while roughly 19% of alcoholics remain sober within the first year.[56] Much of the unsuccessful statistics of recovery programs has to do with the lack of social reinsertion programs following treatment. With few-to-none opportunities, and a minimum self entitlement and social empowerment, men and women of all ages give up on themselves and return to the streets towards an outcasted life in addiction.

53 IAFA News, "¿Qué significa para Costa Rica que se disminuya en un 5% el presupuesto que se le otorga a IAFA proveniente de la Ley de Tabaco?", IAFA.co.cr, July 6, 2019, Accessed on December 2, 2019, https://www.iafa.go.cr/noticias/561-que-significa-para-costa-rica-que-se-disminuya-en-un-5-el-presupuesto-que-se-le-otorga-a-iafa-proveniente-de-la-ley-de-tabaco

54 IAFA News, "¿Qué significa para Costa Rica que se disminuya en un 5% el presupuesto que se le otorga a IAFA proveniente de la Ley de Tabaco?", IAFA.co.cr, July 6, 2019, Accessed on December 2, 2019, https://www.iafa.go.cr/noticias/561-que-significa-para-costa-rica-que-se-disminuya-en-un-5-el-presupuesto-que-se-le-otorga-a-iafa-proveniente-de-la-ley-de-tabaco

55 "World Top 20 Project", accessed January 22, 2020, https://worldtop20.org/costa-rica

56 The Recovery Village, "Drug Rehab Success Rates", TheRecoveryVillage.com, November 25, 2019, Accessed on December 2, 2019, https://www.therecoveryvillage.com/treatment-program/related/drug-rehab-success-rates/#gref

Taking these facts into consideration, one could recognize an enormous and underused workforce that could benefit through social reinsertion programs; resulting in positive socioeconomic change amongst the most vulnerable populations. How can the production of bio-materials through bio-design affect positively a sector that has been marginalized by society? Would the creation of non-technical work opportunities aid a social illness and help recovering addicts become productive members of society? What would be the psychological effects on these patients after interacting and co-working with these living organisms?

From Reality to Utopia - Putting it all together

The previously presented situations have provided tangible and very current examples of economic, environmental and social adversities that Costa Rica is facing. These adversities, however could become the main ground to develop holistic initiatives that approach economic, environmental and social opportunities through the introduction of bio-design solutions.

Part III - A glimpse into the world of Growers

From Utopia to Reality - Licensed to Create

Although the basis of bio-technology has been historically around since the domestication of plants and animals by human beings[57], the past two decades have been crucial for the development of synthetic biology. With further technological developments and an environmental crisis underway, global interest for synthetic biology is leading to the exploration of opportunities and benefits for both the developed and developing world.[58]

The growing industry of biotechnology thrives on outstanding development from scientists, farmers and designers who are driving organisms towards the edge of futuristic discovery. Cases such as the work of Tina Gorjanc are pushing the boundaries of biotechnology through the cultive of human tissue on stem cells to create lab-grown human skin for uses as leather in the textile and fashion industry.[59]

A new age of design is looking forward into renewable and compostable materials which can be easily grown; such as mycelium, bacterial cellulose and plant fibers. Who are they and what are they creating? What businesses and economic opportunities have they developed? How do they draw the line between science, art and design, to give value and function to these environmentally conscious materials?

The following section looks into the work of 9 different projects which are using organisms such as mycelium, bacterial cellulose and plants to create modern solutions through sustainable materials.

Fig.9 Mushroom Footwear (M.Montalti)

Fig.10 Mycelium Packaging (Krown)

Fig.11 Mushroom Leather (Mycoworks)

57 Yuval Noah Harari, Sapiens (Harper 2014), 73

58 "Biodesign for the Bioeconomy UK Synthetic Biology Strategic Plan 2016", Synthetic Biology Leadership Council (SBLC), accessed January 25, 2020, https://connect.innovateuk.org/documents/2826135/31405930/BioDesign+for+the+Bioeconomy+2016+DIGITAL+updated+21_03_2016.pdf/d0409f15-bad3-4f55-be03-430bc7ab4e7e, 29

59 "Cuir d'ADN", http://www.tinagorjanc.com/, accessed January 25, 2020.

The Growing Lab by Officina Corpuscoli

Led by Maurizio Montalti, Officina Corpuscoli is a Netherlands based studio which focuses on the research and exploration of mycelium and its potential towards the development of new materials and applications in product design. The team has explored the production of furniture, lamps, floor tiles, leather and even footwear. The collaborative groups 3D designers, biologists, bio-technologists, business developing managers and modeling engineers, to take on a multidisciplinary approach.[60]

Krown Design & Ecovative

Netherlands based Krown Design and partner company Ecovative (Europe and USA), have revolutionized mycelium growth with their Grow It Yourself Kits. The company has successfully included their packaging alternatives in products of renowned businesses such as Dell Computers, which have adopted the use of mycelium blocks to replace styrofoam. Krown Design sells products in their online shop varying from wine coolers, lamps, poufs and tables; at prices that range form €36.00 and up to €470.00 a piece.[61]

MycoWorks

Based in San Francisco, MycoWorks develops a mycelium based material with very similar properties to animal skin leather. Using Ganoderma lucidum, a medicinal mushroom used widely in Asia, the company has managed to create a material that is strong, flexible and durable. This material can be grown into any shape or size and relies on organic waste, signifying a carbon-negative material that is also entirely biodegradable.[62]

60 Seetal Solanki, Why Materials Matter (Munich, London, New York, Prestel Verlag, 2018), 128

61 Kate Franklin and Caroline Till, Radical Matter (Munich, London, New York, Thames & Hudson, 2018), 208

62 Kate Franklin and Caroline Till, Radical Matter (Munich, London, New York, Thames & Hudson, 2018), 198

Coconut Water Leather by Malai

Based in Kerala, South India, Malai Design Studio has developed a leather - like textile created by bacterial cellulose. Malai collects coconut water that would otherwise become discarded by the coconut industry. The liquid is set to ferment under humid conditions in which a bacterial fermentation process occurs. Their materials range in use, from medical implants to cosmetics, food, textiles and more. This bacterial cellulose is a positive alternative to leather, as it is water resistant, fully biodegradable and vegan.[63]

Fig.12
Coconut Leather (Malai)

Fig.13
Biocouture by Suzanne Lee (S.Lee)

Biocouture by Suzanne Lee

Suzanne Lee has experimented growing kombucha-based material SCOBY (Symbiotic Cultive of Bacteria and Yeast) to create unique fashion design pieces. The process shifts away from damaging animal based, cotton and synthetic materials which are currently dominating the textile industry. Although she acknowledges that bacterial cellulose will not be a replacement for cotton, leather and other textile materials, she does envision it as a smart and sustainable alternative that may aid our precious and vulnerable resources.[64]

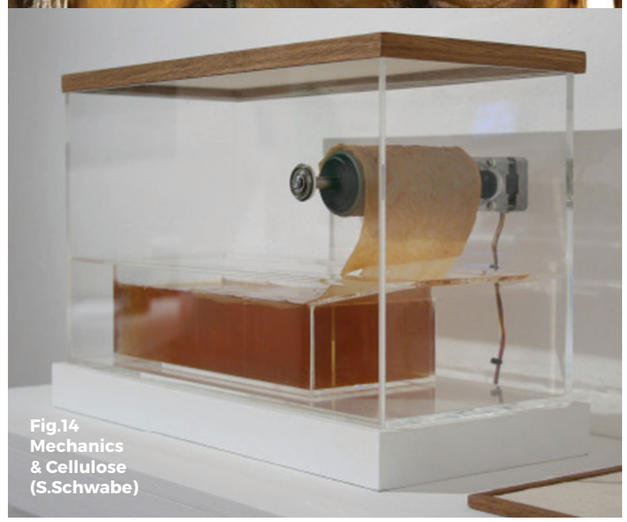


Fig.14
Mechanics & Cellulose (S.Schwabe)

Stefan Schwabe & Jannis Hülsen

Stefan Schwabe & Jannis Hülsen are German designers and artists who have explored the growth of bacterial cellulose in various artistic and design approaches. Combining bacterial growth with abstract art, mechanical engineering and modular building, they have managed to create machines that grow and manipulate bacterial matter.[65]

63 Seetal Solanki, Why Materials Matter (Munich, London, New York, Prestel Verlag, 2018), 118

64 "Suzanne Lee: Grow your own clothes", YouTube video, posted by "TED", May 6, 2011, https://www.youtube.com/watch?v=3p3-vl9VFYU&t=244s

65 Lidija Grodzanic, "Could bacteria-grown materials be the future of building?", Inhabitat, April 20, 2015, Accessed on December 2, 2019, https://inhabitat.com/could-bacteria-grown-materials-be-the-future-of-building/

Totomoxtle by Fernando Laposse

London-based, Mexican designer Fernando Laposse, has found great use in the largest of all cereal crops in the World: maize. Overcoming crop waste, Fernando uses corn husks which would generally be burned, to create a veneer for tiles and marquetry. The social approach of Laposse's project encourages indigenous farmers to recreate the transformation themselves, resulting in a new economic opportunity for the community. The material is versatile enough to be laser cut into different patterns which make use of the variety of colors that some native Mexican corn husks offer.[66]

Desserto by Adrián López Velarde and Marte Cázarez

Mexican entrepreneurs and designers Adrián López Velarde and Marte Cázarez, recently developed Desserto, an organic leather produced from Nopal, a cactus that grows plentifully throughout the Mexican Republic. With the aim to create a sustainable alternative to animal leather, the duo set their focus into developing a cruelty free, chemical and PVC free Cactus Leather which is partially biodegradable and has a durable and resistant lifespan of above 10 years. The product was successfully showcased in the latest edition of the International Leather Fair Lineapelle 2019, this past October in Milan, Italy.[67]

Fig.15
Totomoxtle
(F.Laposse)

Fig.16
Desserto
(A.López)

Fig.17
Algae Dome
(SPACE10, IKEA)

66 Seetal Solanki, Why Materials Matter (Munich, London, New York, Prestel Verlag, 2018), 95

67 Christian Parcerisa, "Vegan cactus leather from Mexico: new favorite for luxury at Lineapelle Milan", Fashion United, November 1, 2019, Accessed on December 2, 2019, https://fashion-united.com/news/fashion/vegan-cactus-leather-from-mexico-new-favorite-for-luxury-at-lineapelle-milan/2019110130675

Algae Dome by SPACE10

IKEA's future-living lab, SPACE10, based in Copenhagen is developing technology using one of the worlds fastest-growing organisms: Micro-algae. These photosynthetic organisms may thrive in sea water and fresh water and are responsible for up to half of the world's oxygen production. Along bioengineer Keenan Pinto, SPACE10 created the Algae Dome at the 2017 CHART Art Fair. The Dome was a self-growing, CO2 capturing, oxygen producing installation.[68]

Getting on Board - The time to Grow

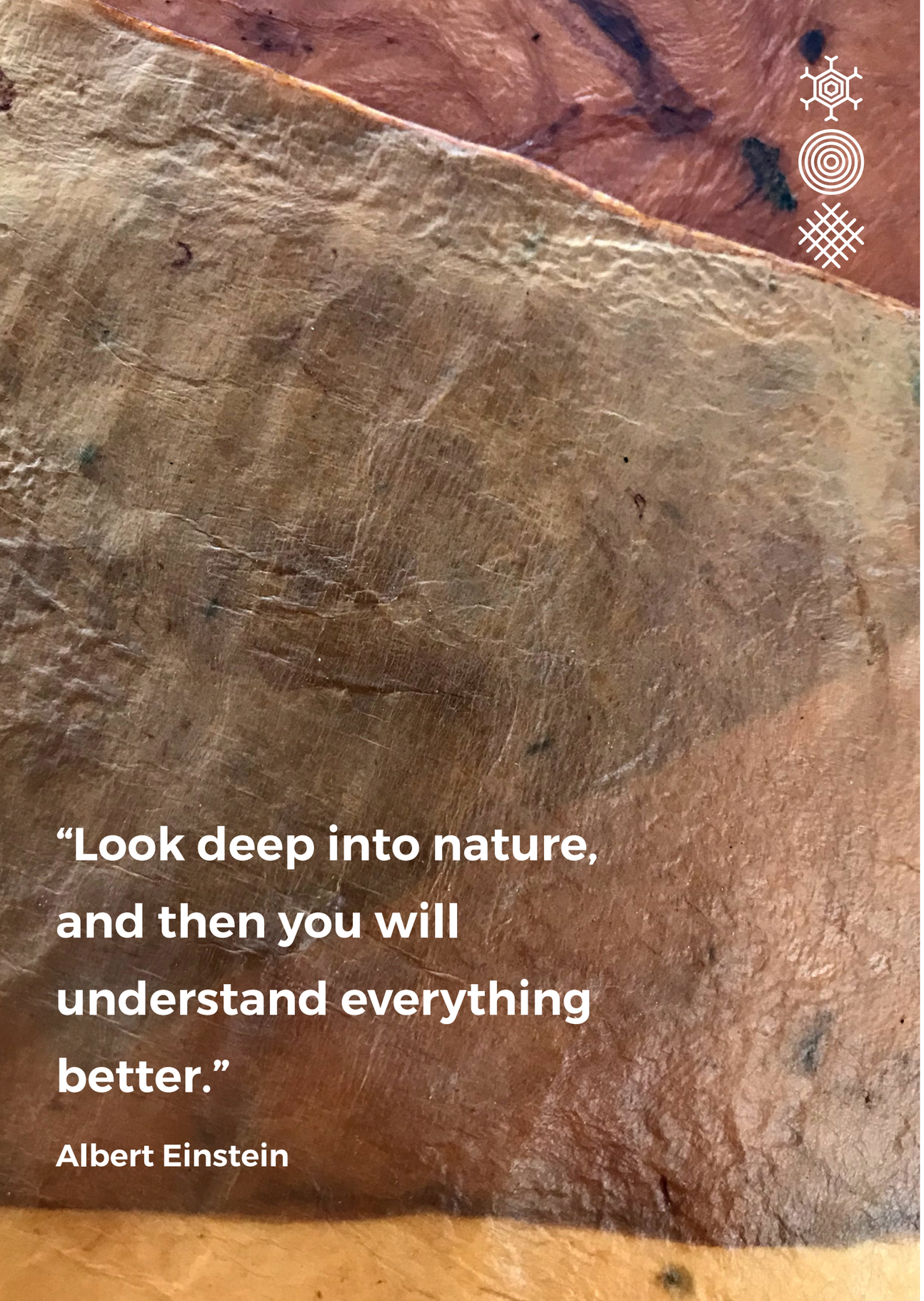
As environmental pressure rises upon humanity, the tendency of design and economies must flow towards sustainable approaches and new bio-technological developments. Designers are aspiring to 'play' with these new materials before jumping into dead end commercial applications, with the purpose of discovering the possibilities which they may offer. The role of design is becoming fundamental in the exploration and research of bio-materials and posterior creation of bio-economies.

"We must flow our creative process through the domains of science, engineering, design and art, interlacing the inputs an outputs of each discipline in order to reach the changes in perception that our future requires."[69]

-Neri Oxman

68 Seetal Solanki, Why Materials Matter (Munich, London, New York, Prestel Verlag, 2018), 214

69 "Abstract: The Art of Design Neri Oxman: Bio-Architecture", Netflix Season 2, Episode 2.



Part IV - Grow

Growing Relationships

Before settling into conclusions, the final piece of research in this project consists of an experimental approach through design to the use of three different materials: Mycelium, Bacterial Cellulose and Plant Fibers. The intention is to discover the viability of working with these materials by understanding firsthand the growth process, and visualizing the implications required for the production of these organisms; and eventually exploring the applications that each material may offer.

This experimental phase looks into artistic expressions to test and become familiarized with each of the materials stated.

Fungal Mycelium

Mycelium is the vegetative part of fungi. It absorbs nutrients and energy from decomposing substances in soil or other substrates. It grows expansively in web-like colonies.

Supplied by Krown.bio, the material comes in a 1kg mix of substrate colonized by a type of Ganoderma mushroom. The substrate provided is hemp. Growing instructions for this organism are extremely simple but require clean, sterilized materials and surfaces to avoid cross contamination with molds and bacteria.

The process consists basically of ‘feeding’ the mushroom flour, which is mixed on a substrate (initially hemp). The mycelia begin to colonize the substrate and expand as fiber-like networks of small roots. Sealed in molds or containers with a little air flow, the mycelium adapts to any shape and grows in little as 4-5 days. The organism requires low light and temperatures between 20-27˚C to thrive. Lower temperatures may cause it to become dormant.[70]

Once the substrate is fully colonized, one can extract the material out of the container and ‘neutralize’ the organism by naturally dehydrating it (but may become only dormant, and revive under specific conditions) or baking it to make it fully inert.

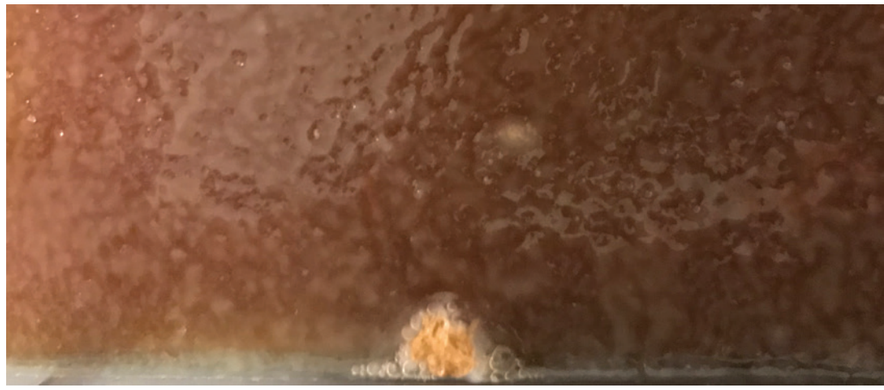
70 “Ecovative Mycelium Material”, KROWN.bio, accessed January 25, 2020, https://s3-us-west-2.amazonaws.com/ecovative-website-production/documents/Grow-It-Yourself-Instruction-Manual-v1.0.pdf

Bacterial Cellulose

Bacterial cellulose is an organic compound produced by certain types of bacteria. In this case, SCOBY (symbiotic culture of bacteria and yeast), is a syntrophic mixed culture of yeast and bacteria used in production of several traditional foods and beverages.[71]

The process consists basically of feeding the organic compound sweet tea (black tea + water + sugar) on which it feeds while growing a layer of bacterial cellulose on top the liquid. Adapting to any surface shape, the SCOBY will continue to thicken as it ferments the liquid. The organism requires oxygen, low light and temperatures between 20-27˚C. Lower temperatures may cause it to become dormant.

Once the desired thickness is obtained the SCOBY can be dehydrated to obtain a leather like material.



71 “How to Grow Leather-Like Material Using Bacteria (Making Kombucha Leather)”, YouTube video, posted by “The Thought Emporium”, May 1, 2017, https://www.youtube.com/watch?v=Ds8ZFzOwGeI&t=255s

Plant Fibers

Plant fibers are generally composed of cellulose, often in combination with other components such as lignin. Plant fibers are classified according to their source in plants.[72]

•Bast or stem fibers, derived from the fibrous bundles in the inner bark of plant stems.

•Leaf fibers, which run lengthwise through the leaves of monocotyledonous plants.

•Seed-hair fibers, such as cotton.

The process to extract these fibers is far more complicated, beginning with the industrial production of pineapple. After the crop has been harvested, the agroindustrial waste can be collected. After the fruit has been picked, the whole plant: leaves, stem and roots are discarded by the industry.

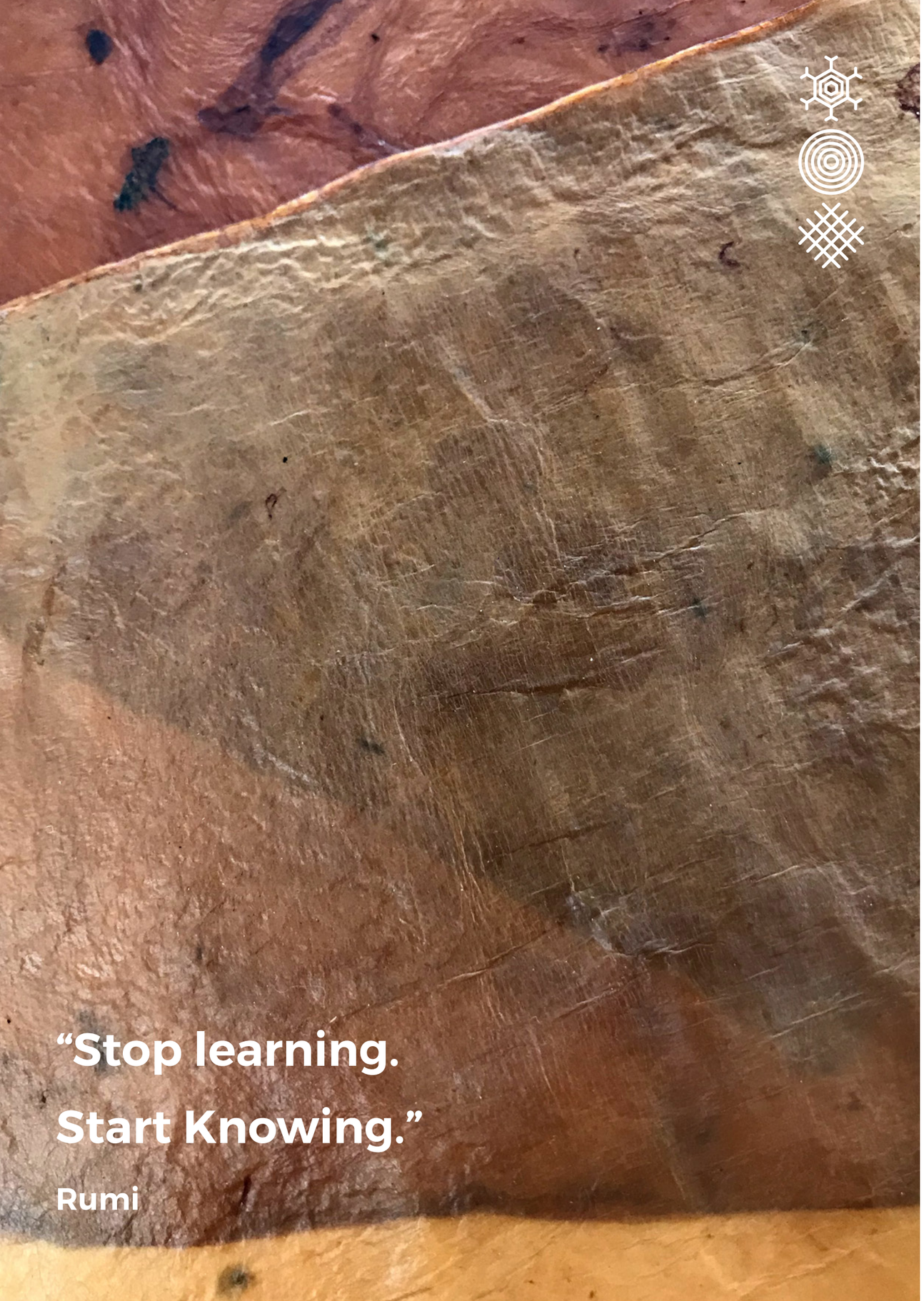
Pineapple leaves can reach up to 1 meter in length. These leaves are harvested, cleaned and snapped open. The leaves are then drawn into a defibrillator which removes the leaf cells leaving only its fibers. The fibers are then left to dry and later processed through a chemical procedure. A final brush is applied and then the resulting fibers can be spun or woven.

72 M. Sfiligoj Smole, S. Hribernik, K. Stana Kleinschek and T. Kreže, Plant Fibres for Textile and Technical Applications, July 31st 2013, https://www.intechopen.com/books/advances-in-agrophysical-research/plant-fibres-for-textile-and-technical-applications

Love, Hate, Love

After developing experiments and trials with the previously mentioned materials, I can now understand better the challenges and opportunities that the production of each organism may bring. Although I was able to successfully harvest all the materials and use them in design applications; I was also met with several failures.

Downsides such as contamination by other organisms, the ‘gross factor’ of people towards the materials and restrictions in time and space are important considerations to address in the near future. Failure brought only more interest in mastering the process and effectiveness of these organisms. My next approach towards these materials will focus more on the aesthetics and functionality of the design output, while hopefully creating an economic value to thrive on.



Conclusion - An Introduction to the Future

Visualizing the next steps towards design, research and biomaterials

The development of this project has introduced me to the current affairs of bio-design and bio-materials. Understanding how materials have shaped our economies, developed technologies and fulfilled our industrial needs in the food, product, fashion and packaging industry is relevant to visualizing future solutions to the waste crisis; locally and globally.

It is fundamental to look into the latest bio-technological trends to envision the opportunities that could be exported to and explored in Costa Rica. The innovations through bio-design may lead to create economical, social and environmental goals within my country. The importance of developing valuable networks here in the United Kingdom are crucial for me to develop my entrepreneurship aspirations and future projects back in Costa Rica.

Taking into consideration the opportunities and/or challenges that Costa Rica faces regarding social, environmental and economical realities may open a dialogue for proposals and objectives to develop with the local government. By acknowledging the adversities and benefits present in the country, I can create a basis to introduce new sustainable business models in several industries, aspiring for positive solutions focusing on bio-design and bio-materials.

Finally, by understanding and learning the process in which certain bio-materials are produced, I can now look forward into projecting a scaleable operation to develop growing technologies. Through such initiatives I can also aspire to create economical opportunities that may support marginalized communities.

The next steps for me to take consist basically on approaching bio-materials through design. This next stage involves a creative input that aims to develop functional outputs. The personal challenges include mastering the production process as well as breaking through the ‘gross factor’ among the potential consumer that accompanies some of these materials. The search for aesthetics, functionality and economical viability are fundamental to be capable to aspire towards the previously mentioned goals.

- Diego Miranda Seevers

Grow

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Ecovative Mycelium Material, KROWN.bio. Accessed January 25, 2020.
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