

Design for Plants:
Posthumanist Approach to Speculative Design for Plants

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Abstract

Plants have been viewed through an anthropocentric lens by humans resulting in the undermining of plant intelligence. More specifically, this happens due to the belief that the only correct way of expressing cognition is defined by the human experience. This thesis examines how posthumanism can be applied to Speculative Design strategies to reshape how humans interact with plants. The thesis project is split into two explorations providing viewers with alternative possibilities for how humans can rekindle their relationship with plants and the natural world. The first exploration speculates about how in the future humans might use wearable technology to communicate and build relationships with plants through meaningful interactions. The second exploration uses drawings to depict an idealized future for plants once stronger relationships between humans and plants are established. The goal of my thesis is to see how design can encourage a change in attitude toward plants.

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Glossary

Angiosperm: A species of plant that bears flowers and fruit.

Anthropocentrism: An ideology that prioritizes human beings and well-being at the center of importance over all other species.

Anthropomorphism: The interpretation of assigning human characteristics to non-human entities.

Cognition: A range of mental processes that enable obtaining, storing, and retrieving information.

Cross-pollinate: A process of plants fertilizing, by transferring the pollen grains (sperm) to another plant's egg-bearing organ. Cross-pollination can be achieved through wind dispersal or animal pollinators.

Germination: The process of a seed becoming a sapling.

Human-Centred: A characteristic that has a focused concern for humanistic values and welfare.

Humanism: A philosophy that values the welfare of humanity through finding a universal truth about human nature and experience.

Ontology: The philosophical study of classification and explanation of beings. Examining what types of entities exist and how they can be categorized.

Plant Agency: The capability for plants to have individual power to act on their own will.

Plant Intelligence: A form of intelligence that can only be expressed by plants. The plant's ability to acquire knowledge and skills relevant to plants.

Posthumanism: A philosophy that values the welfare of all species, not just humans, by rejecting the universal truth created by humanism. The philosophy looks to find alternative modes of being that are not exclusive to humans.

Sentience: The capability of having and expressing conscious thoughts and feelings.

Speculative Design: A branch of design that generates non-commercialized solutions for social issues, by posing an alternative future and perspectives. Can be used as a tool for critical thinking.

Symbiotic Relationship: A long-term relationship between two organisms of different species.

Vascular Tissue: A type of plant tissue that transports water and nutrients up and down the plant's stem.

Volatile Organic Compounds (VOCs): A compound (created by molecules) that can be easily evaporated at room temperature. VOCs are released as gases.

Introduction

The goal of this thesis is to use design experiments to investigate the misconception that plants are dormant and lack cognition, at least as it is understood by humans. While the belief that plants are unable to have conscious thoughts is not harmful in itself, the assumption results in the poor treatment of plants. Specifically, plants are treated as objects or viewed as mere resources for human use, rather than living entities. Two main contributors to this school of thought are the sizable ontological differences between humans and plants and the belief in one universal method of expressing intelligence that stems from humanism. This thesis creates possible design experiments as a way of probing and questioning that aim to find ways to begin to dismantle this notion and asks the question, “what does it take for humans to connect with the natural world and create meaningful relationships with the inhabitants of the plant kingdom?”

Plant intelligence is an ongoing debate in which scientists and philosophers are still navigating the field. As the plant experience is so distant from the human experience it is difficult for humans to observe how a plant might demonstrate cognition. Perhaps this is why humans are more comfortable in concluding that plant intelligence is non-existent. One goal of the thesis is to challenge this restricted perception of plants and reposition this view so it considers plants from a less human-centred perspective and considers a plant’s perspective.

While the thesis utilizes emerging scientific evidence of plant intelligence, I recognize this may not be sufficient when addressing a change in perspectives on plants, therefore ideas from posthumanism are used to address why humans have these biases. Ideologies from posthumanism support my thesis to begin to examine how existing species hierarchies can be dismantled and reconsider the existence of plant agency. Speculative design is used to help think through these issues and materialize them through design artifacts. I examine alternative

possibilities and scenarios that reshape how humans interact with non-human species and rekindle our relationship with plants and the natural world. My research questions are:

1. How might posthumanism help to rethink plant cognition and sentience?
2. How can posthumanism inform Speculative Design strategies to imagine new worlds and de-center human perspectives?
3. How can design strategies help change our perspectives and rekindle our relationship with plants?

The design works are speculations that ask the question, “what if?” They are not meant to be design solutions that claim to prove the existence of plant intelligence. Nor will my designs claim to be a solution to anthropocentrism. The projects aim to examine how plants are treated currently and spark discussion about how humans can work to create a stronger interconnectedness with plants and equally cohabit the planet.

Literature Review

To understand the current discussion on plant intelligence, it is important to know the history of cognition and examine the metrics that are used to detect intelligence. These metrics put certain species, specifically plants, at a disadvantage when measuring intelligence. The definition of intelligence is still yet to be definitively defined by biologists, psychologists, and philosophers. However, the ethnologist David Stenhouse defines intelligence as an *animal's* ability to adapt to its behaviour and problem-solve over its lifetime (1974). Stenhouse's criteria focus on behaviours and create biases for highly reactive animals, including humans, to achieve higher levels of intelligence as behaviours are easily monitored through movements (Trewavas, 2003) (Calvo & Lawrence, 2023). This definition of intelligence becomes problematic when applied to plants. While plants seem immobile to the natural human eye, plants can move but at a time scale slower than humans, creating an illusion of stillness (Calvo & Lawrence, 2023). Therefore, normative intelligence testing can be ineffective or pose difficulty when observing plant behaviours. Stenhouse's definition of intelligence echoes other philosophers' take on defining intelligence, as Patricia Churchland a philosopher specializing in neurophilosophy writes:

“If you root yourself to the ground, you can afford to be stupid. But if you move, you must have mechanisms for moving, and mechanisms to ensure that the movement is not utterly arbitrary and independent of what is going on outside.” (1986, p.13)

Stenhouse and Churchland both build their ideologies on intelligence using animal characteristics and capabilities, then apply the criteria to plants. There is an obvious disadvantage, but instead of addressing these factors, it is concluded that plants cannot have the ability to have cognition at the same level as animals. Although Stenhouse's theory of intelligence allows the possibility of non-human animals to have the ability to be intelligent, other philosophers such as Daniel Dennette are heavily sceptical of non-human animal intelligence or consciousness altogether, as it differs too much from intelligence displayed in humans. In

Dennette's *Kinds of Minds*, he describes animal intelligence as a reactive instinct rather than a conscious decision. He implies that these actions displayed in animals are just the design of their nervous system that causes animals to display intelligent seeming behaviours. He writes:

“These creatures hunted, but didn't think they were hunting, fled but didn't think they were fleeing. They had the know-how they needed. Know-how is a kind of wisdom, a kind of useful information, but it is not represented knowledge.” (2008, p.163)

However, both theories from Stenhouse and Dennette use humans as a standard to create requirements that purposely exclude non-human species to fit the definition of intelligence. Philosopher Étienne Balibar calls it the humanity/animality dichotomy, where humanity is defined once it breaks away from its animal origin (Wolfe, 2010). A predicament where humanity is constantly being defined as the characteristics that set humans apart from animals. Therefore, the differences between humans and non-humans compose the criteria of intelligence. Traits and capabilities that are exclusive to humans become the markers of cognition.

Another ontological difference that disadvantages plants is the physical difference in structure from humans. Plants lack the anatomy of the human neurological system, therefore, this basis becomes a topic where scientists debate the validity of plant intelligence. The classical definition of cognition requires a complex neural system, like the human brain and neurons, to undergo mental processes such as learning and retaining memory (Parise, Gagliano, & Souza, 2020). Due to this misconception, animals that possess smaller brains have their intelligence and cognitive abilities minimized, while plants that completely lack a neural system are viewed as incapable of any cognitive activity (Trewavas, 2003). Psychologist James J. Gibson boldly states in his book, *The Ecological Approach to Visual Perception*:

“We shall treat the vegetation of the world as animals do, as if it were lumped together with the inorganic minerals of the world, with the physical, chemical, and geological environment. Plants in general are not animate; they do not move about, they do not

behave, they lack a nervous system, and they do not have sensations. In these respects they are like the objects of physics, chemistry, and geology.” (2014, p. 3)

While this was written in the twentieth century, scientific evidence in plant cognition was limited and human perceptions were narrow. As more evidence of plant intelligence emerges, the classical definition of cognition is challenged, and new approaches open up ideas of cognition beyond just humans.

Another misconception proven false by scientific evidence is the claim that plants cannot be sentient beings as they cannot consciously strategize within the ecosystem (Robinson et al., 2020). As plants fall at the bottom of the pyramid of the food chain, it is easy to assume plants are at the mercy of herbivores and omnivores. A study by Veits et al. recorded that plants are actively aware of their surroundings and can strategize nectar production to increase the chances of plant reproduction (2019). In the study, Evening Primroses could recognize the sounds of flying insects and increase nectar production to incentivize pollinators to cross-pollinate. Another study by Takabayashi & Dicke recorded plants strategizing to eliminate feeding insect herbivores, by signalling to predatory insects to prey on the herbivores (1996). Plants can communicate information and warning signals within their species and to other animals through scent signals called Volatile Organic Compounds (VOC). Plants can actively control their VOC emissions in certain contexts. Certain plants, such as lima bean, cabbage, maize, apple, and cucumber can sense the presence of insect herbivores feeding and in response can release specific VOCs to attract carnivores, enemies of the herbivores. When healthy plants are exposed to the volatiles from damaged plants, they also increase their defensive mechanisms against herbivores by releasing their own VOCs (Yoneya & Takabayashi, 2014).

The literature review explored how a definition of intelligence constructed around human capabilities can result in a narrow human-centric understanding of plants. The human-centric viewpoint can be better described as anthropocentrism, an ideology that places human beings and human experience at the centre of importance over all other species (Probyn-Rapsey, 2018). Anthropocentrism is not innately harmful, however, the problem arises when the human experience is viewed as superior and is understood as universal, going against how other perspectives are subjected and defined. Thus when plants are viewed through an anthropocentric lens, their cognitive abilities are overlooked as we try to find animal qualities within them. For example, if plants do not communicate using similar methods to animals, they are rendered languageless. To address these misconceptions, my thesis looks to find alternatives to anthropocentric ways of thinking and instead highlight the plant experience. Posthumanism is used to examine how anthropocentric ideas came to be and what methods can be used to de-center the human from the plant narrative. To translate the ideas from posthumanism into design, Speculative Design strategies are used to create a design solution where this perspective can be explored.

Posthumanism

To define posthumanism, it may be beneficial to understand the definition of humanism. The field of humanism is broad and there is no singular definition as humanism branches out into many sub-sections. Humanism can be largely described as a philosophy that looks to find the universal truth and fundamentals of humans by defining the singular model of the human that is based on common human characteristics (Wolfe, 2010). It can loosely be defined as an ideology that values humanity through human nature and experience. Posthumanism is not anti-humanism where it rejects humanity, but it challenges the concept of the singular model of the human and disputes the idea of finding universal truths based only on human nature and experience. It instead looks to alternative modes of being, other than human. For my thesis, I

rely primarily on the work of animal theorist Cary Wolfe. In his book, *What is Posthumanism?* he argues:

“To return, then, to the question of posthumanism, [... it] forces us to rethink our taken-for-granted modes of human experience, including the normal perceptual modes and affective states of *Homo sapiens* itself, by recontextualizing them in terms of the entire sensorium of other living beings and their own autopoietic ways of “bringing forth a world”—ways that are, since we ourselves are human animals, part of the evolutionary history and behavioral and psychological repertoire of the human itself.” (2010, p. xxv)

Wolfe explains that posthumanism not only advocates for the decentering of the human narrative but also requires us to think about how these systems were constructed. Moreover, he argues that humanism creates a normative subjectivity for what the universal human should be, and creates an environment that allows the mistreatment of non-human species that are not aligned with that idealized human model. This requires us to examine what role humans play in privileging our perspectives and making choices that adversely affect non-human species.

Strategies

Design professor Ron Wakkary describes posthumanism as the shift away from the human ways of knowing and remaining open to the possibility of non-human species having their forms of agency (2021). As a designer, Wakkary combines ideas in posthumanism and applies the concept to the collective work of designers, specifically how exploitative humanist design can excessively take the earth's resources for human gain and how that affects the interconnectedness between human and non-human species. Wakkary defines posthumanism as:

“Posthumanism shifts the focus away from the power of self-reflexive human reasoning to situated, partial, and multiple ways of knowing. It points to an acceptance that human agency is not autonomous, perhaps even fragmentary, alongside an imperceivable number of other actors, nonhuman ones, with their own possible forms of agency.” (2021, pp3)

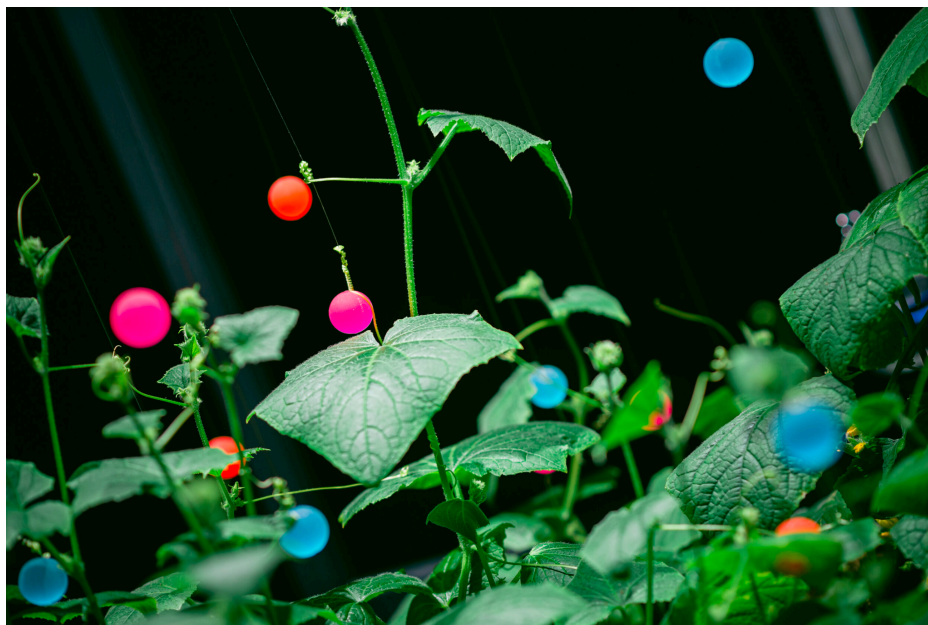


Figure 1: Špela Petrič, PL'AI, 2020

While “Posthumanist Design” is not yet an established form of design, there are examples from art and design that utilize ideas from posthumanism. New media artist Špela Petrič uses live

plants and machines in her performances to blur the boundaries between humans and non-humans. She has a series of works that pose alternative possibilities for non-human bodies but through different methods and approaches. In her piece *PL'AI* (Fig. 1), she creates a performance art acted by plants and Artificial Intelligence driven machinery to demonstrate how plant bodies express the notion of play over several months. The act of playing is captured through timelapse photography, recorded by a camera trained to follow the motion of plants. Petrič interprets play as an expression of bodies and claims it is not limited to humans. She suggests that the plant's interactions with suspended balls can be a form of play. As plants are thought to be motionless, there is a misconception that plants do not have the capabilities to express agency, let alone the ability to play. Petrič uses a method of scientific observation, to document live plants in motion to disprove the belief plants are inactive. She takes a scientific evidence approach to address misconceptions humans have about plants, however, my thesis will take a hypothetical approach. I will focus on addressing how these plant misconceptions are formed and create design artifacts that aim to allow viewers to rethink existing negative fallacies of plants by imagining how the current relationship between humans and plants can be strengthened.

The Plant Sex Consultancy (PSX Consultancy) created by Pei-Ying Lin, Dimitris Stamatis, Jasmina Weiss, and Špela Petrič is another example of posthumanist ideologies within design. The majority of design is created for the human user, but the *PSX Consultancy* looks to find ways to design methods for non-human users. *PSX Consultancy* is a hypothetical agency that takes on personified plant clients who need help with the process of reproducing. Due to plants being rooted in place, some rely on animal pollinators or human intervention to successfully reproduce. *PSX Consultancy* designs personalized solutions for each plant species based on their problem, calling the process plant-centred design. The *Canna indica* client (Fig. 2) is one of five scenarios. The *Canna Lily* is a popular garden plant but faces the issue of unsuccessful

cross-pollination. The plant originates from tropical climates in Africa and is mainly pollinated by hummingbirds (Lin, et al., 2014). When uprooted and grown in colder temperatures, the hummingbird pollinators are substituted for bees. While the Canna Lily incentivizes their pollinators with nectar in exchange for pollination, certain species of bees will bypass the plant's stigma (pollen receptors that collect pollen to germinate) and cut holes into the lily's funnel to directly access the nectar. To increase the chances of fertilization, the *PSX Consultancy* created a device that pools the flower's nectar near the stigma through capillary action to increase the chances of cross-pollination.

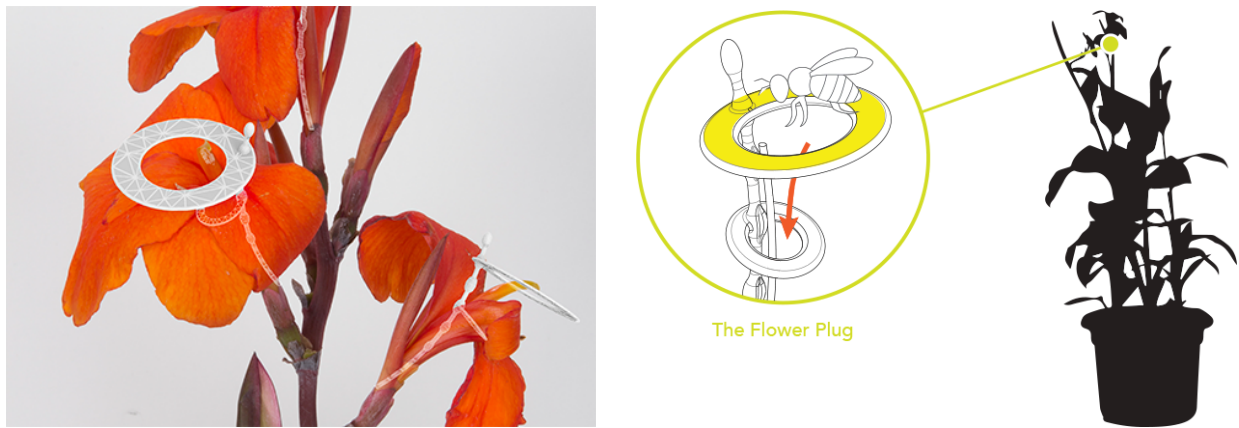


Figure 2: Pei-Ying Lin, et al., The Plant Sex Consultancy (*Cana indica*), 2014

The *PSX Consultancy's* view on plant-centred design is directly taken from human-centred design methodologies. Therefore, the project requires the plants to be personified and act like human clients at a design consultation. In certain scenarios, the plants are anthropomorphized and can talk using the English language to explain their problems. For this thesis, anthropomorphizing plants will be avoided. While the concept of designing for non-human species aligns with posthumanist ideologies, if that requires plants to be personified like humans it creates the notion that design solutions for non-human species are only worth solving when the user is human-like. The goal of my thesis is to dismantle misconceptions of plants created

by humanist thinking, therefore, creating a design solution that requires the plant to align with human values and characteristics would go against the scope of the thesis.

Speculative Design

To dismantle these fallacies surrounding plant capabilities, I turned to strategies from Speculative Design. Not to persuade viewers to adopt non-anthropocentric views, but instead, to consider scenarios from the near future in which plant intelligence is pre-established, and to imagine how our relationship to the environment would differ. Speculative Design can be used to generate new scenarios to envision future systems for social issues and visualize how the future could be by analyzing the present day. In Dunne & Raby's *Speculate Everything*, they explain that while traditional forms of design are expected to provide a commercial solution to a problem, Speculative Design privileges questions over solutions in an open effort to generate dialogue and new possibilities to help solve a problem (2013). They argue:

“This form of design thrives on imagination and aims to open up new perspectives on what are sometimes called *wicked problems*, to create spaces for discussion and debate about alternative ways of being, and to inspire and encourage people's imaginations to flow freely. Design speculations can act as a catalyst for collectively redefining our relationship to reality.” (2013, p. 2)

Speculative Design is a strategy for critical thinking and is beneficial when exploring new perspectives on larger complex issues that do not have a fixed orientation but are used to hypothesize about possible design directions. Dunne and Raby put their ideas into action in *Foragers*, a commissioned piece for *Protofarm 2050* as part of Design Indaba for the ICSID World Design Congress. The prompt was to create a solution for future farming in response to food shortages and the increasing world population. According to the United Nations, seventy percent more food needs to be produced in the next forty years to compensate for food shortages (Dunne & Raby, 2013, p. 151). Despite food scarcity being a dire issue, the solution is unclear and the scope of the problem is so large that it is hard to know where to start.

To address this issue, Dunne and Raby create hypothetical tools allowing humans to consume 'non-human food' to maximize nutrition intake (Fig. 3&4). These devices are inspired by the digestive systems of animals and utilize microbial stomach bacteria to accelerate the digestive process (Dunne & Raby, 2013). The devices are meant to serve as ideas, rather than actual tools to solve food scarcity. The devices were presented in a gallery exhibition, where viewers were encouraged to interpret the tools and draw their own connections to the topic.

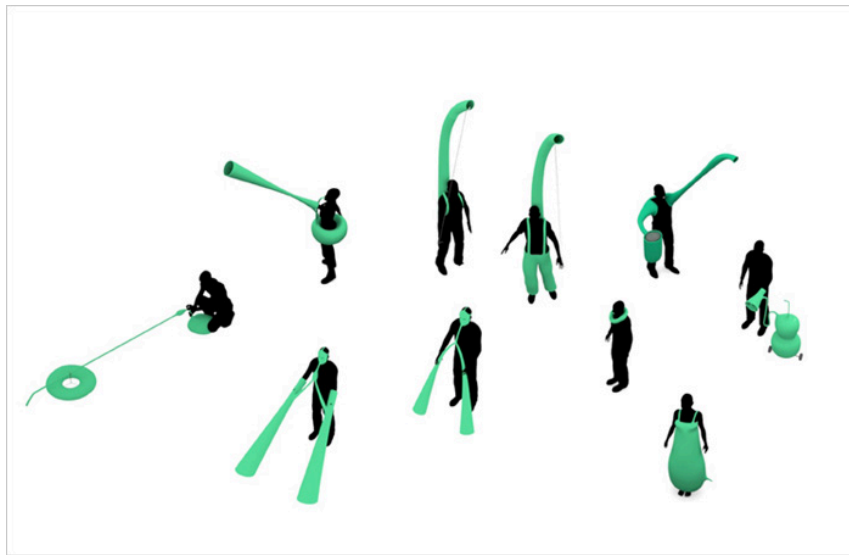


Figure 3: Dunne & Raby, DESIGNS FOR AN OVERPOPULATED PLANET: FORAGERS, 2009



Figure 4: Dunne & Raby, DESIGNS FOR AN OVERPOPULATED PLANET: FORAGERS, 2010

Similar to food scarcity addressed in Dunne and Raby's *Foragers*, the topic of plant intelligence and sentience is intricate. Proving the existence of plant cognition is still an ongoing debate among researchers. Due to the complexity of the topic, it is difficult for the general public to take part in the debate or form personal opinions. As a designer, I am not seeking to contribute scientifically to the debate about the existence of cognitive capabilities in plants. Instead, this thesis uses Speculative Design strategies to visualize the contents of the debate on plant intelligence and act as a springboard for viewers to start their own dialogue. To achieve this, I use current evidence of plant intelligence such as plants' ability to communicate and interact with their surroundings to envision an ideal future. I propose worlds in which plant intelligence is established and design artifacts for those worlds imagining scenarios that allow viewers to be more receptive to the concept. My speculation on the future is not a declaration nor a prediction of the future, but instead, an investigation of how designed artifacts can help to imagine less human-centred scenarios that recognize plant intelligence.

Methodology

The capabilities of plants are diminished as they do not adhere to the “human norms” created by ideologies from humanism and anthropocentrism. Due to this thinking, the kingdom of plants has been reduced to agent-less objects or resources for human gain. The goal of the thesis is not to debate the validity of plant sentience or convince viewers to adopt this mindset. Instead, the design artifacts serve as provocations by asking viewers to form their own opinions on creating meaningful relationships with the inhabitants of the plant kingdom. This is done by offering viewers a new perspective on plant intelligence to undo the biases created by humanist thinking. In the thesis, I design fictional futures where plants’ abilities are not constrained through anthropocentric thinking. These futures envision ways humans can better co-exist with plants. For the design component, I create artifacts that would exist in these fictional futures.

The project consists of two parts exploring different points of relationship with plants. The first component visualizes how humans and plants can build stronger relationships through personal interactions. The design aims to bridge the gap between the human experience and the plant experience through a device that is designed for humans to understand the language of plants. The second component is a speculation on how rekindling relationships with plants can lead to an idealized future for them. In my proposed future, plant species evolve and the new forms and structures are displayed through illustrations. While both components follow separate approaches to providing viewers with new perspectives, each project challenges the belief that there is one universal method of being, which is supported by anthropocentric thinking. The first project looks at plants’ cognitive abilities through language systems while the second project explores plants’ idealized futures.

Shifting Perspectives: Plant Communication

The first exploration addresses the relationship between humans and plants through wearable technologies. One point that prevents humans from connecting with plants is the language barrier. The common belief that plants are languageless or do not have the mental capacity to communicate creates a barrier that discourages humans from connecting with plants. This project proposes a wearable device to address the language gap.

To understand why plants are considered languageless, it is important to examine the definition of language and more importantly, who's method of communicating is included and excluded from this definition. The broad definition of language can be explained as a system of exchanging information. However, the more common interpretation of language requires the information to be conveyed audibly. The Merriam-Webster definition reads, "the words, their pronunciation, and the methods of combining them used and understood by a community" (Merriam-Webster, n.d.). This description is biased towards the humans' mode of communication and is exclusionary towards plants and other living beings, as they do not communicate using the concept of words. Similar to how the definition of intelligence is created by the capabilities of human cognition, the same can be seen in the definition of language. This creates the notion that plants are languageless as they do not fit the human standard of language. However, it has been recorded that plants have their systems to communicate through an array of methods, which will be later explained.

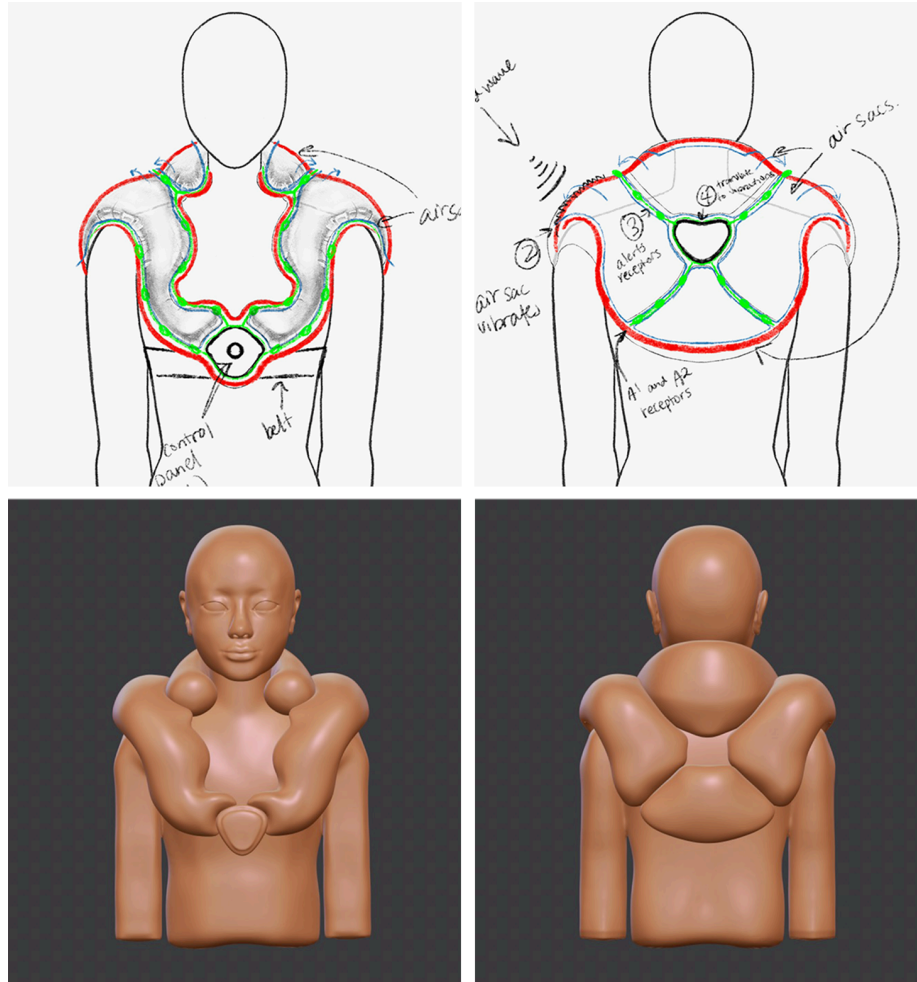


Figure 5a (Top Row): Jessica Kim, Sketches of Communication Suit (Procreate), 2023

Figure 5b (Bottom Row): Jessica Kim, Sketches of Communication Suit (Nomad Sculpt), 2023

This exploration aims to spark a debate: if plants and humans could communicate with each other, would that change our perspective of plants being agent-less? To accomplish this, I created a fictional future where humans can understand the language of plants and engage in conversation with them. To engage in the language, humans must wear a suit that alters their senses to be more receptive to the modes of plant communication (Fig. 5&6). This hypothetical suit is the artifact I designed, which includes the outer appearance and interface for controlling the various modes of communication. The suit's interface is composed of three devices that correspond to three modes of plant communication, sound, touch, and smell. Since this suit is

speculative, the final output is created as a virtual 3-dimensional model, where the final product will be presented as a conceptual video depicting how the suit would be used Refer to Appendix A for more images.

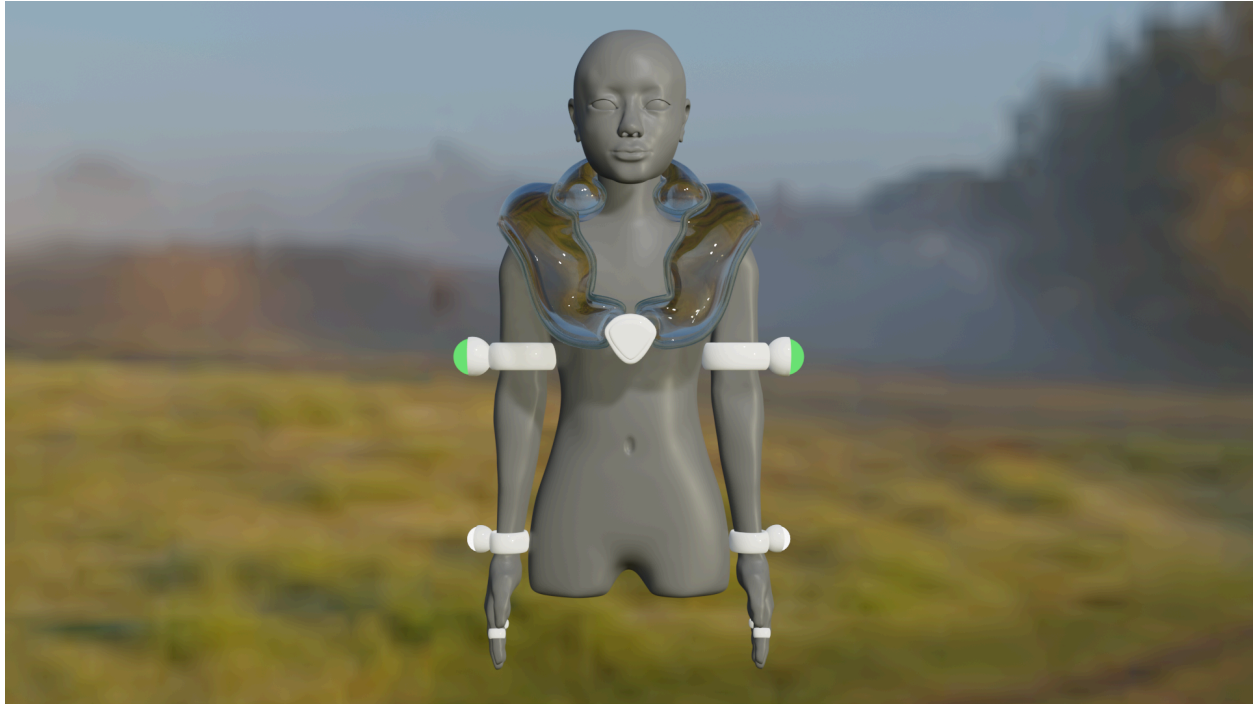


Figure 6: Jessica Kim, Communication Suit, 2023

Despite the common misconception that plants are mute, recent scientific studies suggest they are capable of detecting and emitting their own sounds. According to a recent paper by Khait et al., plants can display signals of distress through sounds of clicking and popping (2023). They have reported that while healthy plants can create clicking sounds, plants that are dehydrated and physically damaged would make the sounds more often. It was also revealed that the type of stress emitted a specific pattern, allowing researchers to identify individual plants from their sounds. Based on the findings of this study, the evidence aligns closely with Merriam-Webster's definition of language – a series of audible sounds, when combined create a message that can be understood by a community. Despite this data, humans have been unaware of plant

communication because their sounds can barely be heard with the naked ear. In the study by Khait et al, researchers used ultrasonic microphones to record plant conversations. Their work challenges our anthropocentrism contributing to misconceptions about plants, and it is an issue I want to address with the design of the first sound device.

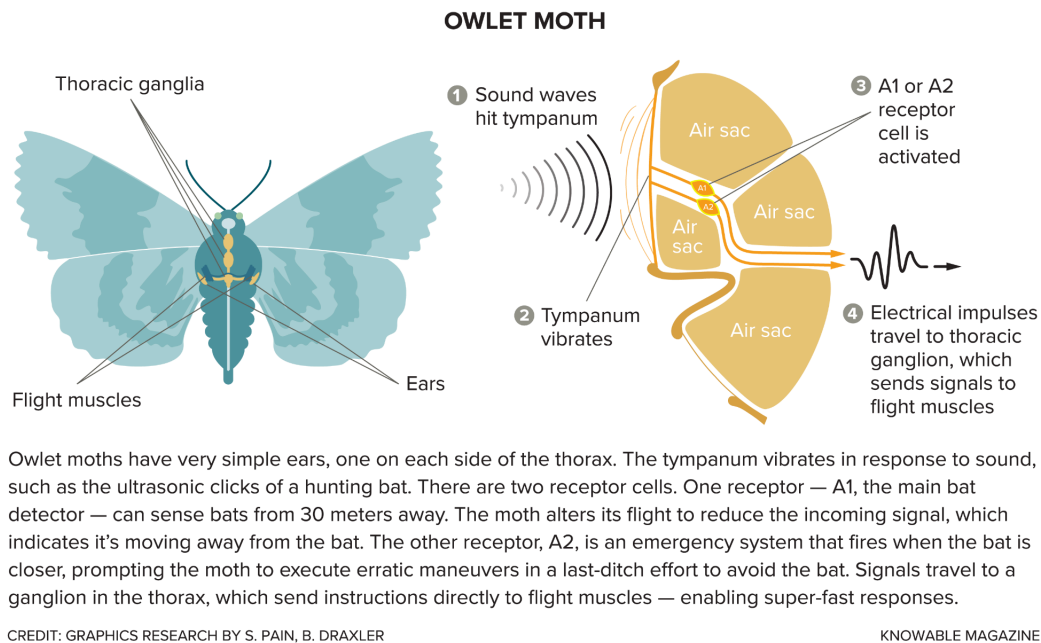


Figure 7: S. Pain & B. Draxler, Graphic Research, 2018

Human perception of sound is different from plants and other animals. Sound is produced by vibrations or waves, and the structures in our ears can translate these waves into audible sounds. Different species have unique sensory organ structures that detect sound waves through vibrations. Moving away from the “human norm” of hearing, I discovered the insect kingdom has a unique array of sensory organs including the Owlet Moth, which has an organ under their wings that allows them to detect ultrasonic soundwaves (Pain, 2018). The organ is comprised of air sacs that vibrate when sound waves are present (Fig. 7). These vibrations trigger the moth’s receptors and alert the moth if predators are nearby. I was inspired by this

structure and designed the sound component of the artifact around this idea as I wanted to recontextualize what sound is and challenge how sound can be perceived from a non-human perspective. Instead of the suit emitting audible sounds, the suit is designed to translate these sounds as larger tactile vibrations. The structural design of the sound interface wraps around the shoulders and neck of the human user (Fig. 8). Sound is associated with ears, therefore, I wanted to challenge this “human norm” and allow the human user to feel sound throughout the body.



Figure 8: Jessica Kim, Communication Suit (Sound Interface), 2023

As the human user wears this suit outdoors, they may witness a symphony of vibrations due to several plants emitting their sound. It is up to the user to move around to listen to the conversation between plants or focus on an individual plant and interact more intimately. If the human user decides to engage in communication with a singular plant, they can activate the touch component of the device.

Despite language being commonly used through audible modes of communication, humans, animals, and plants have more than one way to convey information. For the other two devices, I explore and highlight how plants communicate using non-audible modes. The touch interface is based on the electrical pulse communication of plants. The idea behind this interface mode is inspired by how plants communicate with electrical pulses through their root systems to other plants and even with mycelium (Bridle, 2022) (Sheldrake, 2021). These plants create networks of communication portals with fungi, called the Wood Wide Web, coined by scientist, Suzanna Simard. Fungi grow around the roots of plants and through their roots they can also use the network to barter resources, creating a symbiotic relationship. Plants can barter sugars and lipids created through photosynthesis to exchange with fungi for soil minerals (Sheldrake, 2021). These fungi barter networks can spread between several plants, and plants use the fungi network to share nutrients with nearby trees (Wohlleben, 2016). It has more recently been discovered that underground root communication is not the only method plants can transfer information through tactile methods. Plants can communicate through signals that occur through leaf-to-leaf contact as a study conducted by Szechynska-Hebda et al. displays (2022). The study explains that electrical signalling could be detected on the surfaces of plant leaves, but also can spread throughout the plant's tissues. This mode of communication was reported to be effective in plant communities, as a single distress plant can alert the community to synchronize a defence mechanism by spreading signals through its leaves.



Figure 9: Jessica Kim, Communication Suit (Touch Interface), 2023

This touch interface is inspired by the Wood Wide Web connections and the above-ground leave connections. As the plant emits electrical pulses, indicating its well-being status, the device will identify these tactile signals and translate them into visual signals through light sensors (Fig. 9). The touch device is comprised of bands that are worn around the human's arms, wrists, and fingers. The arm devices have light sensors that indicate the health condition of the plant. The human user can interact with plants and touch different parts (etc. leaves, stems, roots), and the hand sensors will detect the electrical pulse signals within the plant. If the plant is healthy, the light will shine white, but if the plant is in any discomfort the colour of the light will diagnose the issue, such as pest infestation, dehydration, or injury.

The third interface is designed on the plant's ability to communicate through scents. As previously mentioned, plants can communicate information through scents, known as Volatile Organic Compounds (Takabayashi & Dicke, 1996). These smells could be floral scents to allure pollinators, or defense mechanisms to fight off pests. If the plants are under attack from insect

herbivores, they can release scents that allure carnivorous insects to prey on the herbivores. Similarly, the wearable suit will have scent receptors that can detect the presence of plant VOCs. Once the communication device detects the plant being under attack from pests, the chest panel will deploy the same VOCs to further entice carnivores to prey on the pests (Fig. 10).

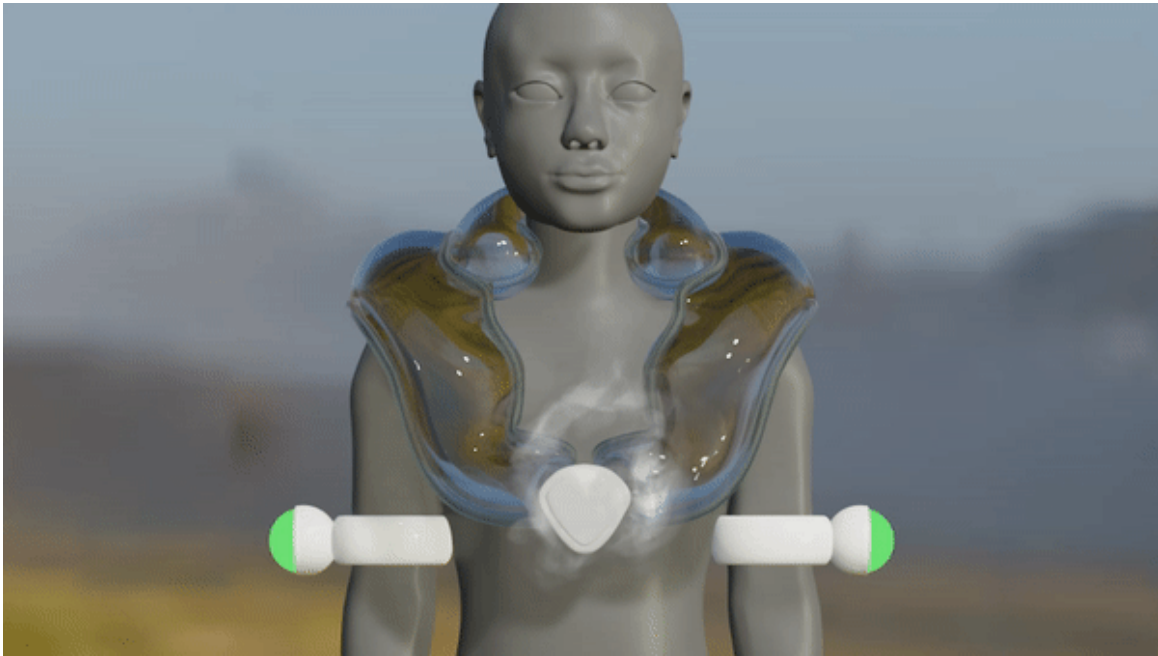


Figure 10: Jessica Kim, Communication Suit (Smell Interface), 2023

Despite the surge of emerging evidence of plant intelligence, the general public is still largely unaware of plant communication. This speculative suit is meant to provide a new perspective on how humans can be more receptive to the language of plants. Through Speculative Design, I aim to prompt viewers to form their own opinions on plant communication. Whether the viewer believes in the existence of plant languages, I pose the question, “if humans could successfully communicate and understand plants, how would it alter the common perspectives of plants?” Would that alter the current definition of language? Would it change how humans treat plants?

Reimagined Futures: Plant Evolution

The second exploration extends from the ideas explored in the first project. If the first project examines how humans can build meaningful relationships with plants, the second project will then examine how these relationships would have long-term effects on the quality of life for plants by considering the design of plants and how their futures will evolve. One of humanity's pressing issues is addressing the human-induced changes in Earth's natural ecosystems.

Deforestation, pollution, and the rising global temperatures resulting in climate change can all be attributed to humans' unequal usage of resources and land, which negatively affects all life forms on Earth. The purpose of this project is to get viewers to think of a future where the well-being of all species' is prioritized. As well as asking the question, "what does a future look like when humans have a stronger interconnectedness with plants and can equally cohabit the planet".

To envision a better future for plants, it is crucial to examine how plants are being treated in the present. The long-term effects of humanism have influenced peoples' treatment and perception of plants. The ideology of humanism creates a normative subjectivity based on the human experience which believes there is one universal truth and experience, and any species that does not fit this norm is othered or objectified. Plants have a completely different way of navigating the world to humans. They communicate differently, they procreate in distinct ways, and they also move at a time rate slower than humans. The plant's existence challenges normative subjectivity and demonstrates there is more than one way of being that is not human-centred and universal. Instead of acknowledging the difference between the plant and human experience, anthropocentric thinking falls short of being able to comprehend the plant experience and would rather conclude that it does not exist. Thinking based on humanism justifies treating plants like objects, often leading to humans ignoring how their actions have repercussions. As a result, plants that benefit the lives of humans are beloved and cultivated,

whereas plants that do not influence the lives of humans are left to fend for themselves. This mindset has allowed the extinction of species and the loss of biodiversity over the years. The design artifacts for this thesis would exist in a future where plants can flourish without having ties to humans. It also speculates how plant species could evolve and adapt without the interference of human influence and activity.

One of the goals of this project is to dismantle the idea of plants being less evolutionarily developed than humans and animals due to normative subjectivity. For example, in the evolution of intelligence, it is often thought that intelligence has evolved in a linear fashion meaning the more complex an organism gets, the more intelligent it gets, thus concluding humans are the most intelligent of the species on earth. I wanted to challenge this idea and show how evolution is constant and how it branches out to include other models of evolution. Paco Calvo, a professor in the philosophy of science writes:

“[Plants and animals] exist less on a hierarchical “tree” of life, more in an “adaptive landscape” in which each species is incrementally climbing its own evolutionary slope. Given this, can intelligence have originated *only* in animals? I would argue not.” (Calvo, 2023, p50)

The main goal of the project is to prompt viewers to think of a future where humans and plants can cohabit together. The design artifacts illustrate five fictional evolutions of plants that exist millions of years into the future (Fig 11). I aim to create a generation of plants that evolve new structures and strategies to thrive. I propose these new evolutions will only be possible once humans respect the plants as living entities and create new habits that prevent the objectification of plants, such as preserving plant diversity and plant habitats. I explain how these structures would work by illustrating the outer and inner appearance of these plants. I am highlighting the processes of plants for a better understanding of the plants’ strategies and to

allow viewers to comprehend how plants' way of being is different from humans, challenging humanism's belief in a singular experience.

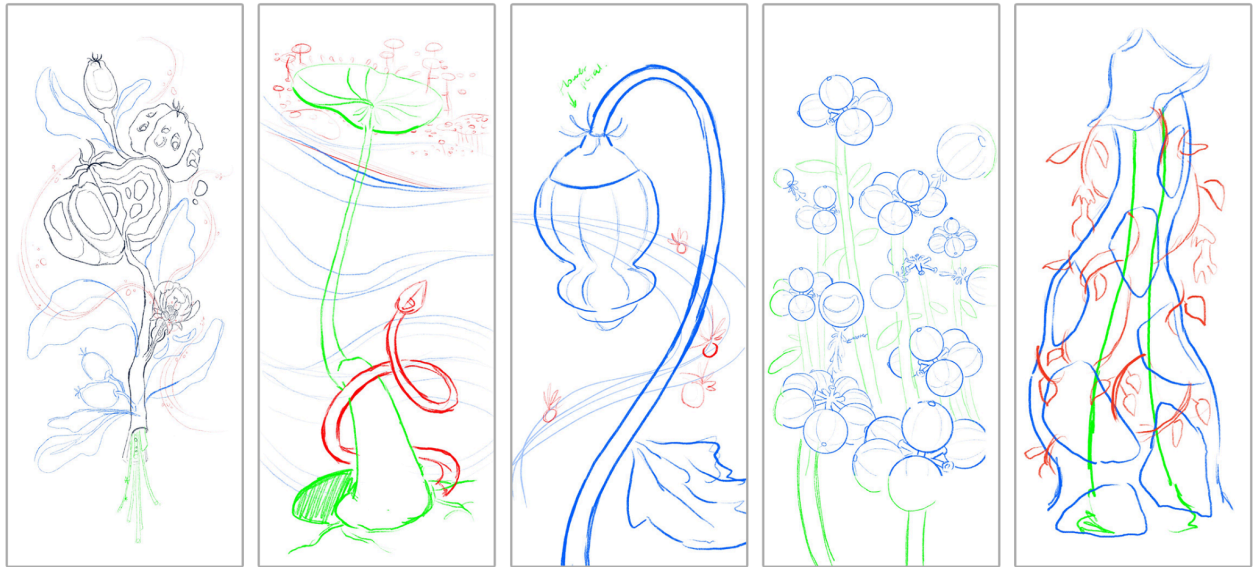


Figure 11: Jessica Kim, Plant Evolution Process Sketches, 2024

The plant evolutions are created by applying Speculative Design strategies informed by ecological and natural selection theories. In this project, I research five different plants and wonder what characteristics can be amplified to give each plant a competitive edge to adapt to their ecological niches and overcome competing plants. The evolutions are presented through a series of animated illustrations and influenced by scientific observation used to create botanical illustrations from Natural History. Through the medium of hand-drawn plant illustrations, these renderings allow for creative liberties that live photography cannot capture. My illustration style focuses on depicting the hidden abilities of plants. To express the liveliness of the plants, I drew them in their natural surroundings and animated them. Refer to Appendix B for more images.



Figure 12: Jessica Kim, *Evolution of Domesticated Plant*, 2024

Evolution of Domesticated Plant (Fig. 12) is one out of five speculations and explores how domesticated plants could evolve. Humans have domesticated plants to alter their genetics to create the perfect produce without considering how this would affect the health of the plant. Domesticated plants are “designed” to fit human needs and wants, as we alter plant genetics to adjust to our lifestyle. Due to modern-day agriculture and the selective breeding of plants, domesticated beings have lost their ability to communicate with each other.

“[When] we step into farm fields, the vegetation becomes very quiet. Thanks to selective breeding, our cultivated plants have, for the most part, lost their ability to communicate above or below ground—you could say they are deaf and dumb [...] Perhaps farmers

can learn from the forests and breed a little more wildness back into their grain and potatoes so that they'll be more talkative in the future.” (Wohllenben, 2015, p9)

For the first evolution, I chose to speculate how an apple tree would evolve without human intervention. For my prediction, I think of characteristics that would be important to the apple tree and not the human consumer. As Wohllenben suggested, this illustration depicts how the apple tree can breed wildness back into themselves.

On this branch, I draw different cycles of the apple fruit (flowering buds, budding apple fruit, apple fruit, and decaying apple fruit). However, this would not be possible in the wild, as the apple fruits on a tree develop at the same time. I wanted to show the different stages of the fruit without having to dissect the branch borrowed from traditional botanical illustrations. In this speculation, I would assume the apple fruit sizes would become smaller, similar to wild crab apples. Humans view apples as a food source, and in response to grocery store standards and consumer demand, farmers have bred apple trees to produce uniform fruit. However, from the plant's perspective, the apple's fruit acts as a storage space for the plant's seeds. The fruit would become asymmetrical and the surface would become uneven without the farmer's intervention. Instead of the plant wasting energy creating sugary fruit, I would speculate the plant would prioritize creating more seeds, causing the fruit to reduce its sugar content. The apple fruit would lose its round shape, and instead take the shape of the seed chamber, creating a shape similar to a bell pepper.

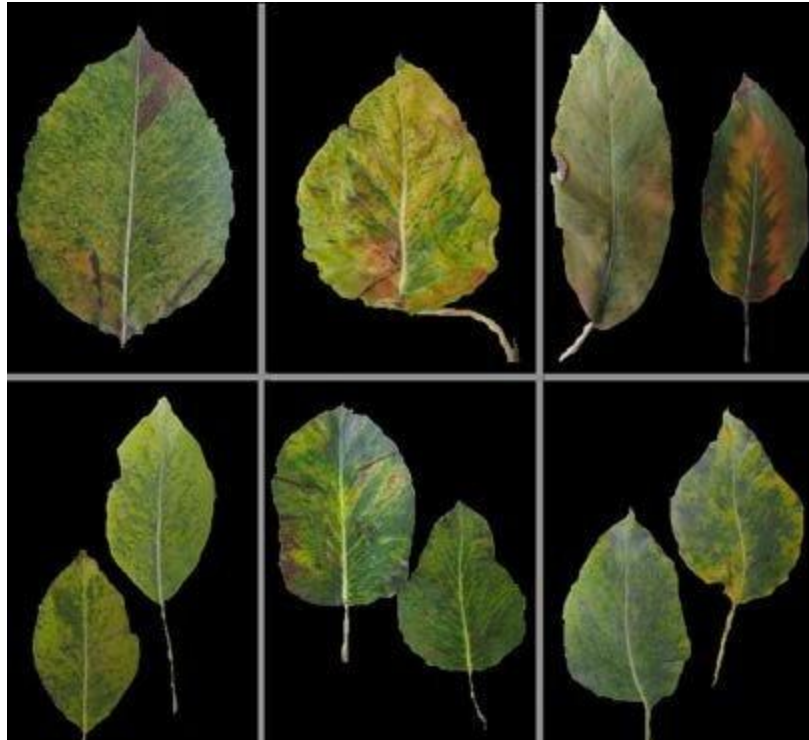


Figure 13: Farmahini, M., et al., Different virus-like symptoms in pear leaf, 2014

Once the seeds are mature and ready to disperse for germination, the apple will evolve to create a method to scatter its seeds without relying on human or animal intervention. The apple fruit will evolve structures similar to a pinecone, where a path will form in the seed chamber to allow the seed to slide out once the fruit dries out. The apple flower also evolves new chambers to allow for a more efficient release of pollen. Clouds of pollen are drawn in a way that depicts how plants might sense pollen, as pollen and scent are qualities that cannot be detected by the human eye. If apple trees were reintroduced to the wild, they would learn how to be self-sufficient and learn to compete for nutrients with other plant competitors. Therefore, the leaves on the apple exhibit signs of nutrient deficiency (Fig. 13). To assist with the internal communication needed to facilitate the evolution of these new behaviours, I visualize the concept of electrical pulse communication towards the bottom of the apple branch which shows how signals move up and down the plant's vascular tissues.

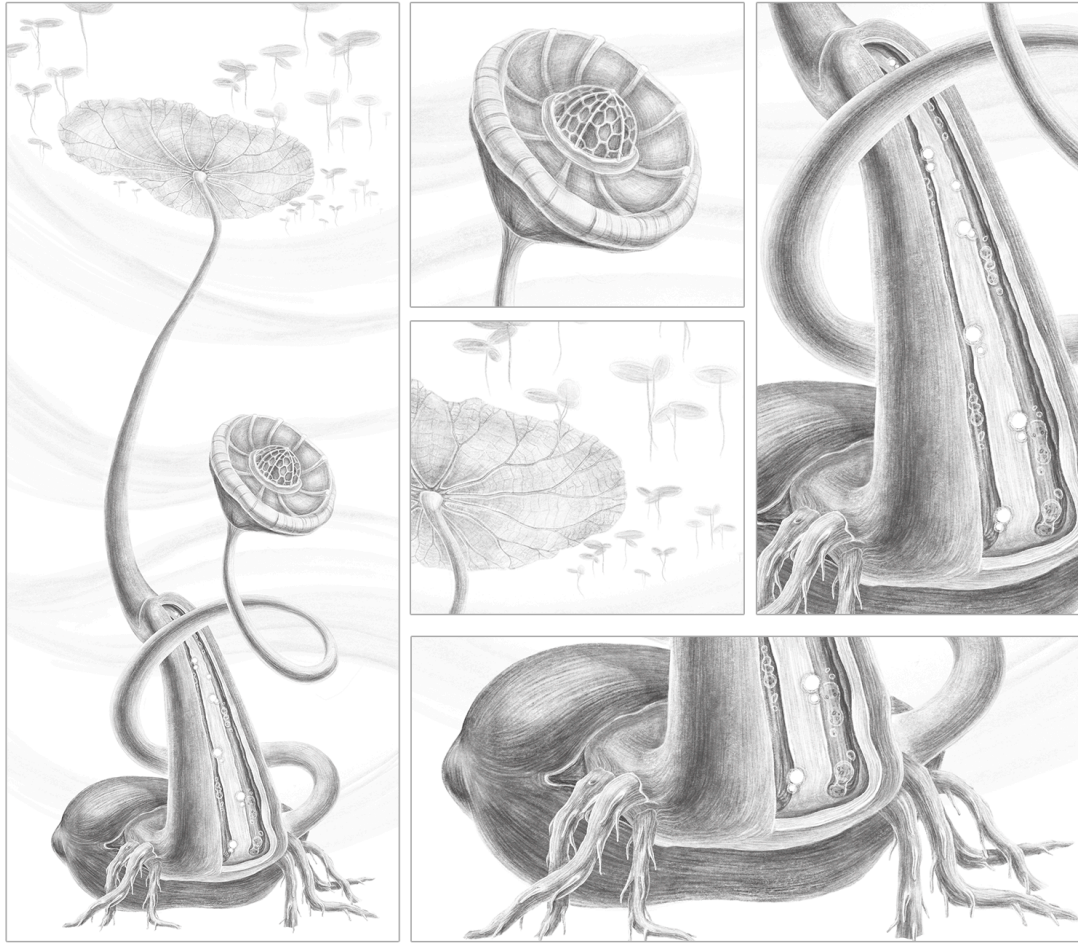


Figure 14: Jessica Kim, Evolution of Aquatic Plant, 2024

Evolution of Aquatic Plant (Fig. 14), speculates about how the water lily could evolve. This plant highlights the social aspect of plants and is an evolution where communication and sharing resources give them a competitive edge in their ecological niche. For most aquatic plants, adequate sunlight is difficult to acquire as the sunlight must penetrate through the water and reach the submerged plant. However, the water lily has a different strategy where the plant will rapidly grow leaves, more commonly known as lily pads, that reach the surface of the water to efficiently photosynthesize like land plants. However, the surface area of the body of water the water lily resides in can be limited, and lily pads must compete with other aquatic plants to receive sufficient sunlight. In this exploration, I think of ways in which the water lily plant can

evolve so they can acquire adequate sunlight through a bartering system similar to mycelium networks in land plants.

To create a social species of plants, I look to community systems present in eusocial insects, such as bees, wasps, ants, and even species of pistol shrimp. These organisms live in colonies and work as a unit to preserve the well-being of the colony as a whole, instead of acting for their own individual well-being. The colony relies on castes that delegate each group to different responsibilities, typically divided into two main groups. The singular queen is responsible for reproducing worker members, and the workers who maintain the health of the colony by collecting resources and protecting from intruders. I was interested in how advantageous eusocial plants could be, by evolving a similar system for plants. In the illustration, I feature the queen lily pad as the largest entity, similar to the queen in eusocial insects. The queen is stationary as it is rooted to the bottom of the pond and will be responsible for gathering nutrients from the soil. The worker lilypads are significantly smaller than the queen, and they have shorter roots that do not reach the soil. These workers float on top of the water and move based on the water currents allowing for a larger mobility range than the stationed queen. The worker lilies can collect sunlight throughout the surface area of the pond. The worker lilies can process the sunlight to create sugars and lipids that are then shared with the queen lily. In exchange, the queen lily will provide the workers with soil nutrients. Having a social relationship allows for aquatic plants to share resources to allow the success of multiple individual plants, instead of creating a fierce competition for survival.



Figure 15: Jessica Kim, *Evolution of Flower*, 2024

Evolution of Flower and *Evolution of Seed Pod* focuses on illustrating the process of seed dispersal but through two completely different methodologies. *Evolution of the Flower* utilizes the natural surroundings, to disperse its seeds while *Evolution of the Seed Pod* grows a structure that helps dispersal. The world of plants has an array of structures that allow for unique ecological strategies. One strategy I wanted to highlight is the dispersal of seeds. As the majority of plants are rooted in the ground once they germinate, it is crucial plants secure an environment with optimal conditions. An optimal habitat for plants would exist of adequate

sunlight, ideal soil blend, sufficient room to grow, and minimal competitors in the vicinity. Therefore, the spot where the seed germinates can determine the success of the plant.



Figure 16: Robert, A., Close up of seeds blowing from dandelion on beige background, n.d.

Evolution of Flower (Fig. 15) explores how plants utilize the wind to transport their offspring to idealized spaces. This illustration is based on the dandelion plant, where once the flower reaches maturity, it creates seeds with a fluffy filament, called the pappus (Fig. 16). This pappus acts like a parachute and is effective at catching wind, allowing the seed to travel long distances. In the illustration, the seeds sit inside a protective structure. Once the seeds are ready for distribution, the protective leaves start to dry up and curl up to allow a pathway for the wind to pick up the seeds.



Figure 17: Jessica Kim, Evolution of Seed Pod, 2024

Evolution of Seed Pod (Fig. 17) is an exploration of plants creating their methods of seed dispersal without relying on natural phenomena like the wind. This plant is inspired by the squirting cucumber plant (Fig. 18). This plant is unique, as the seedpod of the plant is filled with fluid and seeds. Once the seeds are mature and ready to germinate, the seedpod becomes extremely sensitive. If the seedpod is slightly agitated, the pod detaches from the stem and releases the built-up fluid within. This fluid creates a projective force that thrusts the pod backwards. In the process, the seeds within the pods are ejected within the vicinity. The illustration shows a plant that has evolved a similar strategy to the squirting cucumber, where seedpods are filled with seeds and fluid and explode when ready to germinate. It is important

that I illustrate different approaches to solving a common problem for plants. Through these two illustrations, I highlight how diverse plant structures can be.



Figure 18: Botanik Guide, Spritzgurke, n.d.

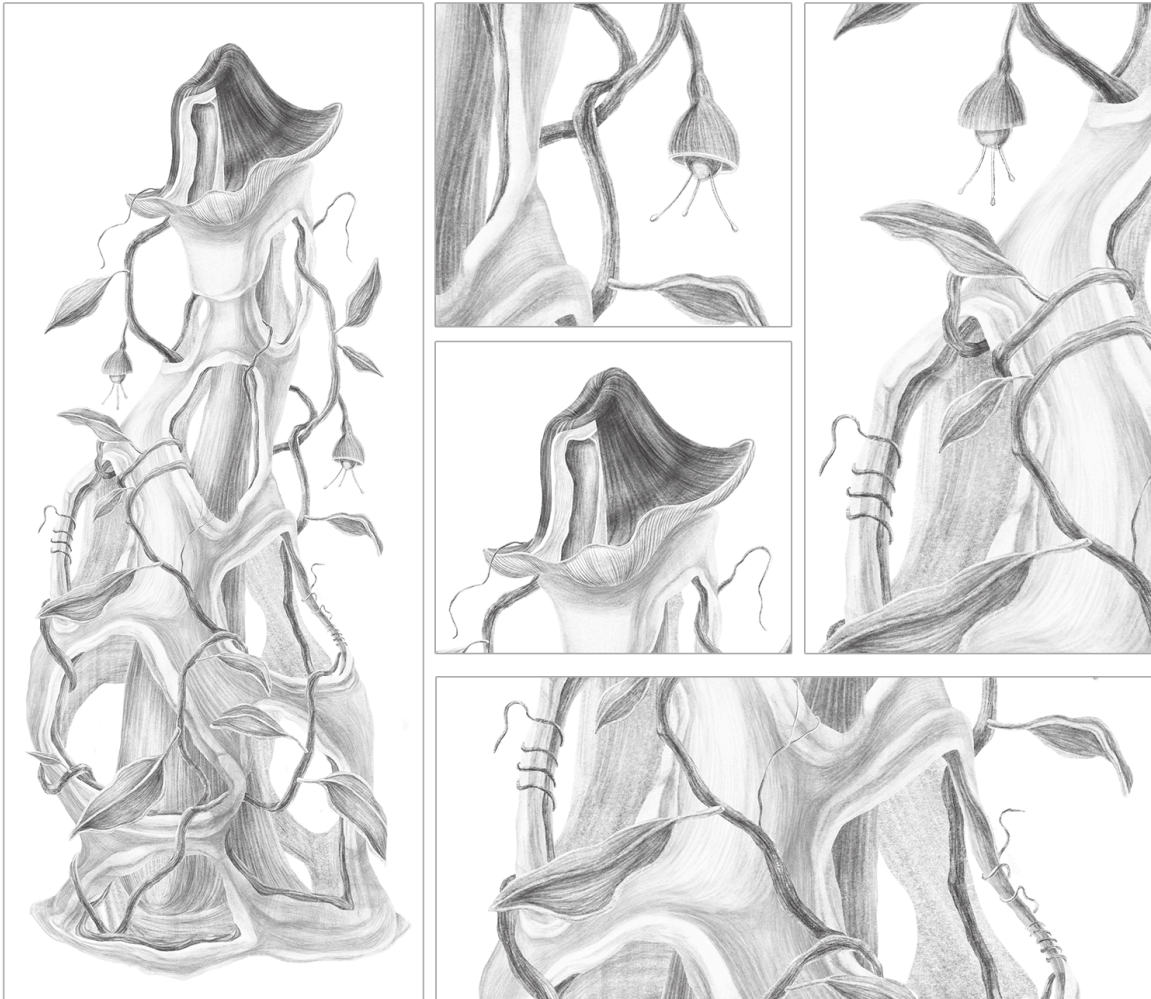


Figure 19: Jessica Kim, Co-Evolution of Plants, 2024

Co-Evolution of Plants (Fig. 19) examines how plants can evolve in response to other organisms. The previous four illustrations highlight plant evolutions responding to adaptation in an environment where plants can flourish without the intervention of humans. The fifth illustration highlights the concept of co-evolution. This is a process when two or more species mutually influence each other's evolution through natural selection, often occurring when the ecological relationship between species is in close proximity. An example of co-evolution can be the emergence of flowering plants and pollinators. One of the most infamous examples is the long-proboscid fly and long-tubed iris, the fly has a long mouthpart that has a similar length to the iris's flower stems (Goldblatt & Manning, 2000). The fly's mouth is the perfect length to

access the iris's nectar, which positions the fly's head near the iris pollen stigmas (Fig. 20). When the fly goes to another long-tubed iris to drink nectar, the process is repeated allowing the fly to consume nectar and the iris to achieve cross-pollination.



Figure 20: Johnson, S. D. et al., Flowers of *Lapeirousia oreogena* pollinated by the long-proboscid fly, 2012

I wanted to explore this adaptive dynamic, of plants evolving in response to other species. This plant evolution co-evolves with fungi and engages in a mutualistic relationship. The evolved fungi are based on the mushroom commonly called, Bridal Veil Stinkhorn (Fig. 21). This mushroom creates a net-like structure which aids the fungi in cross-pollination. I envisioned how a plant could create an ecological strategy based on this mushroom. The proposed plant is a

type of vine that utilizes the mushroom's net structure to climb up and spread its leaves. Based on the mutual relationship, the vine would also share the sugars and lipids created through photosynthesis with the mushroom, while the mushroom shares soil minerals.



Figure 21: Connie Pinson, Bridal Veil (*Phallus indusiatus*) fungi., n.d.

The final illustrations (Fig. 22) are to be projected on a large screen for viewers to observe. The plants can be presented individually, but they are designed to visually fit together as a collection. The illustrations are animated to depict how these plants will move and respond in their natural surroundings. Adding movement to the illustrations will help push the idea that plants are living beings instead of agent-less objects. While each plant's evolution is purely fictional, as these are not scientific predictions on how the future of plants will look like, this project aims to visually hypothesize the future of plants. When imagining the future, the needs and contributions of plants are rarely considered. As humans share this planet with an array of species, how can the future be inclusive to ensure the well-being of every entity? Providing viewers with my visual

speculations of a proposed future with a new generation of plants can prompt viewers to start forming opinions on what possible futures might look like.



Figure 22: Jessica Kim, Plant Evolution Series, 2024

Conclusion

To conclude, my thesis explores the plant experience and ways of being through the medium of design. Throughout my research, I realized how privileging human perception leads to the undermining of plants, and by extension results in the objectification and mistreatment of plants. My body of work asks the question, “how can design help to rethink plant agency and intelligence, in addition to dismantling species hierarchy?” It begins with changing perspectives surrounding plants. Asking viewers to form an opinion on the plant sentience can be challenging, as the topic requires conceptualizing the plant experience which is so distant from the human experience. Design can aid by visualizing and hypothesizing what the plant experience could look and feel like. However, to shift current viewpoints on plant cognition and sentience it is not enough to visualize scientific evidence. The thesis acknowledges that to change perspectives, it is important to understand how biases and misconceptions came to be. The exclusive use of human perception to understand plant life is the cause of the narrow viewpoint of plant capabilities. Therefore, ideologies in posthumanism look to dismantle anthropocentrism and examine how human normative subjectivity discriminates. Applying these ideas is a step towards shifting attitudes toward plants and dismantling species hierarchy.

For the design works, I apply posthumanism ideals with strategies in Speculative Design. The design of each artifact looks to prompt viewers to envision possible ways humans can rekindle their relationship with plants and the natural world. This is achieved by visualizing my opinions on how our relationship to the environment would differ if the validity of plant intelligence and cognition was widely accepted by all. I encourage viewers to start their own dialogue and begin to imagine what their idealized future looks like when humans begin deeper relations with plants. It is important to start asking viewers to think of ways to rekindle relationships with non-human species. Establishing a close interconnectedness with plants is one of the first steps

to addressing the human-induced changes in the environment. Mindsets based in anthropocentrism ignore how human actions can negatively affect plants and other living entities. Issues such as climate change and the degradation of the environment are becoming more critical to the point of being irreversible. It is only with a change in values and beliefs that we can begin to find solutions to these crises. My thesis is a step towards dismantling species hierarchy and anthropocentrism. It is my belief that humans, plants, and all forms of life can co-exist equally with changed perspectives and attitudes.

Appendix A - Shifting Perspectives: Plant Communication Details



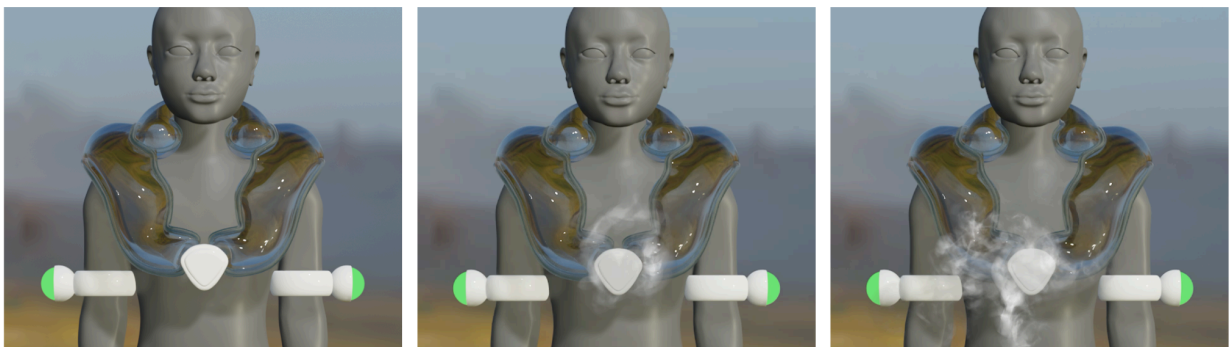
Jessica Kim, Communication Suit - Video (Frame Cuts), 2024



Jessica Kim, Communication Suit: Sound Interface - Video (Frame Cuts), 2024



Jessica Kim, Communication Suit: Touch Interface - Video (Frame Cuts), 2024

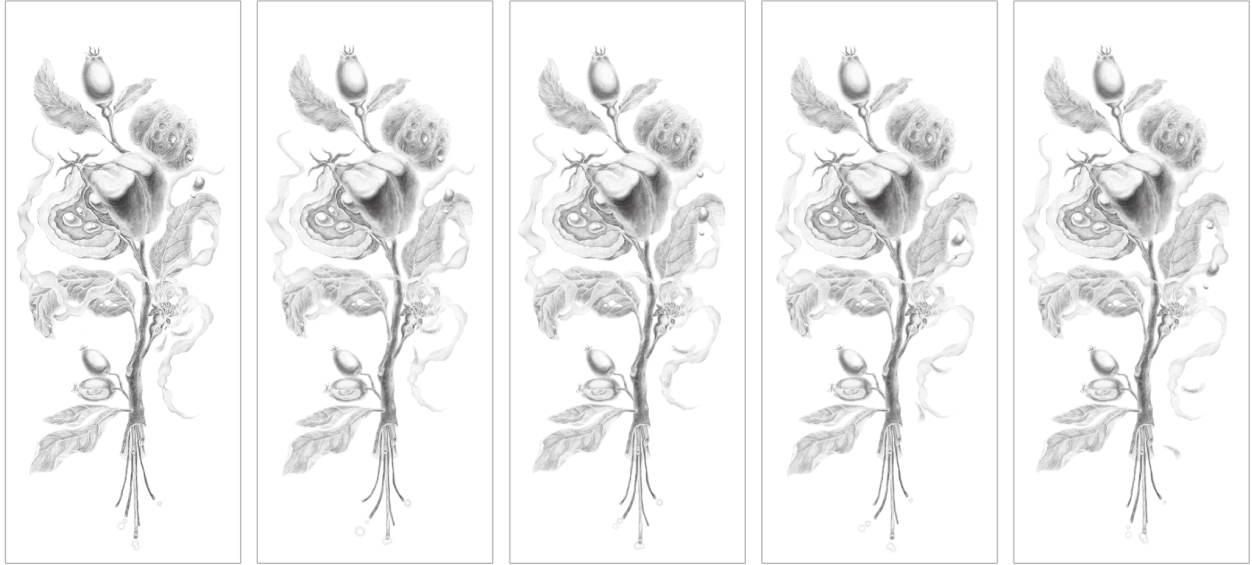


Jessica Kim, Communication Suit: Smell Interface - Video (Frame Cuts), 2024



Jessica Kim, Communication Suit: Conceptual Video (Frame Cuts), 2024

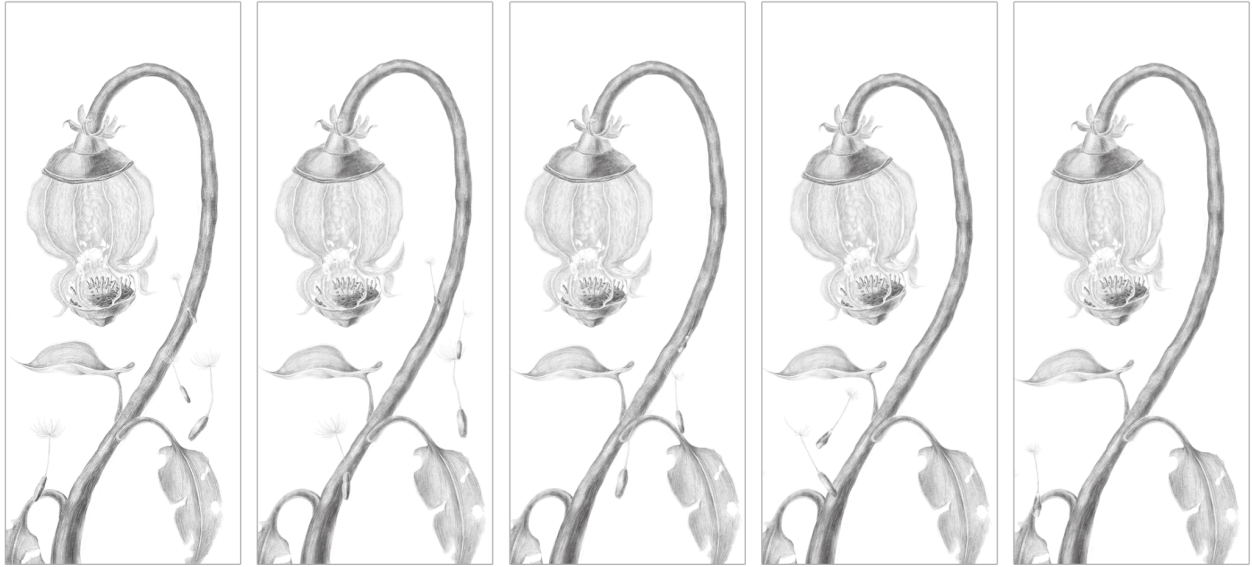
Appendix B - Reimagined Futures: Plant Evolution



Jessica Kim, Evolution of Domesticated Plant - Video (Frame Cuts), 2024



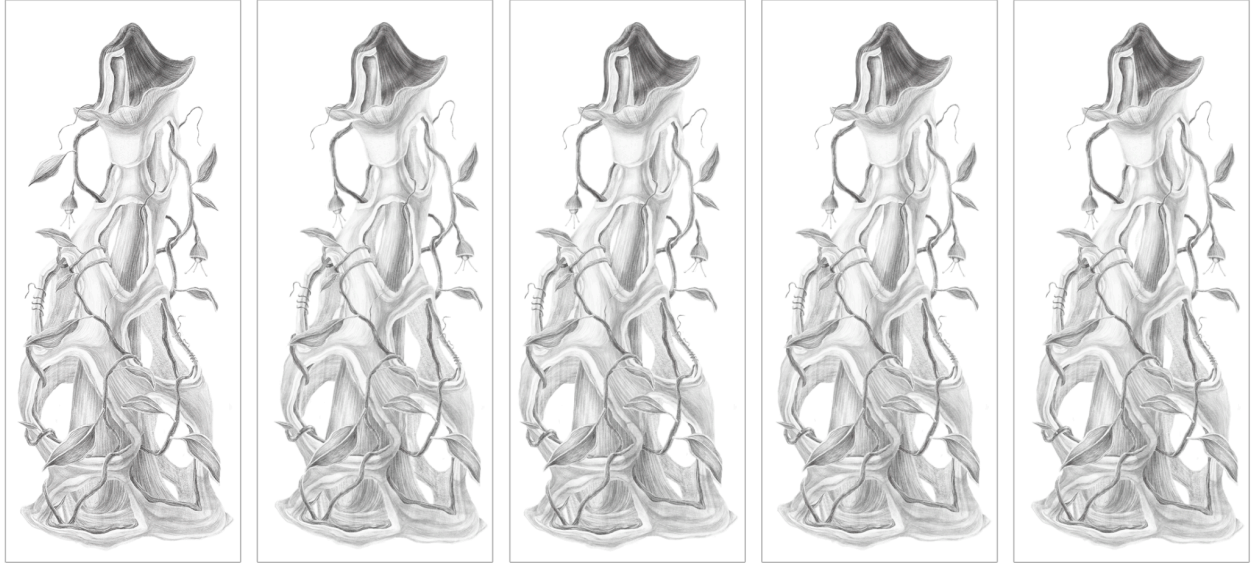
Jessica Kim, Evolution of Aquatic Plant - Video (Frame Cuts), 2024



Jessica Kim, Evolution of Flower - Video (Frame Cuts), 2024



Jessica Kim, Evolution of Seed Pod - Video (Frame Cuts), 2024



Jessica Kim, Co-Evolution of Plant - Video (Frame Cuts), 2024

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