A Landscape in the Air

Designing on a dynamic environment

paisaje
dinámico
ecosistema temporal
landscape
dune
dynamic
temporal ecosystem

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"Un paisaje en el aire" es una reflexión personal sobre cómo operar en un paisaje dunar. Las dunas de Guardamar del Segura (Alicante) han cambiado mucho en el último siglo, desde el año 1900, cuando el Ingeniero de Montes Francisco Mira i Botella comenzó con las tareas de reforestación de las dunas con la misión de evitar que éstas acabaran engullendo el pueblo. El proceso comenzó con algunas construcciones residenciales en los años 30 entre las dunas y el mar, continuó con su acondicionamiento turístico en los años 70-80, la construcción del espigón que modificó la deriva de las mareas en los años 90, y los nuevos proyectos de restauración del paisaje a partir de los años 2000. Este paisaje ha sido ampliamente intervenido, y sus dinámicas naturales siempre han tenido una respuesta a estos cambios. El presente artículo trata sobre el entendimiento de ese ecosistema natural y sus dinámicas existentes a través de la investigación de los elementos que lo forman, lo deforman o colonizan como son el aire, la arena, el agua, la humedad, vegetación, humanos, etc. Ejemplos tales como la captación de humedad en la condensación del rocío del amanecer para sobrevivir de un escarabajo del desierto, o el crecimiento y la supervivencia de la vegetación sobre las dunas, el funcionamiento de las cometas para mantenerse en el aire, incluso el de las maquinas que caminan sobre la playa de un artista holandés, todos ellos son algunas de las herramientas que ayudan a entender e intervenir sobre el paisaje de una manera dinámica. Mientras que pasarelas de madera, espigones o casas son elementos estáticos que se construyen y destruyen en un sistema cambiante, el proyecto "Un paisaje en el aire" integra y acepta esos ciclos de construcción/destrucción como un elemento más. Allá donde el proyecto tenga éxito sobrevivirán los caminos, se implantará la vegetación o se calmará el impacto de la marea. Y donde la naturaleza no acepte el proyecto simplemente desaparecerá, degradándose rápidamente como un árbol que muere o las hojas caducadas que se lleva el viento.

"A landscape in the air" is a personal reflexion on how to work within a dune landscape. The dunes of Guardamar del Segura (Alicante) have undergone significant changes over the last century. Starting in 1900, when forestry engineer Francisco Mira i Botella initiated the reforestation of the dunes to prevent them from encroaching upon the town, the landscape has witnessed transformations. The process started with some residential constructions in the 1930s, continued with the tourist development in the 1970s and 1980s, the construction of a breakwater altering tidal drift in the 1990s, and new landscape restoration projects from the 2000s onwards. This landscape has experienced extensive interventions, and its natural dynamics have consistently responded to these changes. This article aims to comprehend that natural ecosystem and its dynamics by investigating the elements that shape, deform, or colonize it, such as air, sand, water, humidity, vegetation, humans, etc. Examples such as capturing humidity from condensation of sunrise dew to survive like a desert beetle, or the growth and survival of vegetation on the dunes, the functioning of kites to stay aloft, even the one of the machines that traverse a beach by a Dutch artist, all of them are tools that help to comprehend and engage with the landscape in a dynamic manner. While wooden footbridges, breakwaters, or houses are static elements constructed and dismantled within a changing system, the project "A landscape in the air" integrates and embraces these cycles of construction and destruction as integral elements; in places where the project succeeds, paths will endure, vegetation will thrive, or the impact of tides will diminish. In cases where nature rejects the project, it will simply fade away, rapidly degrading like a dying tree or expired leaves carried away by the wind.

INTRODUCTION

The idea for this project stems from the controversies that arise between natural systems and human interventions. While natural systems are governed by dynamic and ever-changing processes, our interventions are often approached in a static manner. Time and these dynamics are responsible for readapting these interventions toward a new equilibrium.

1. CURRENT STATUS OF THE PROJECT AREA

A breakwater (Fig. 1) has been built at the mouth of the Segura River (Alicante), to divert the outflow of sediment from the river mouth, modifying the coastal tidal drift. Currently, the beach does not have enough sand and is shifting its position slightly. This would not be a problem but for the fact that it impacts tourist activity in the area and affects other areas of the landscape.

The harbour had been a long-awaited facility in Guardamar for years. Designed for both sporting and traditional fishing activities in the town, the port and subsequent constructions now integrate seamlessly into the dune landscape at the river mouth , on the edge of the sea.

Parallel to Viveros beach, there is a road that connects the town to the harbour. Access to the beach is via footbridges over the dunes, and the landscape in this area is enclosed by metal fences for its protection. Previously, this area had other uses such as car parks and barbecue areas, but these facilities have been dismantled to regenerate the landscape. Re-vegetation operations were also conducted here to naturalize the landscape and stabilize the dunes. However, these interventions were later modified by the dynamic flows of the site.

Houses on Babylonia beach, built at the beginning of the 20th century when there was plenty of sand on the beach, will disappear as they are now too close to the water due to the retreat of the sand from the coastline. When they are removed, the landscape behind them will change again, as it will be affected by the altered wind patterns previously deflected by the houses.

Fig. 1 – Current status of nature and constructions on the project area.

The pine forest landscape, established to halt the encroachment of the dunes on the town, is now under attack by insects that are destroying it due to drought and the weakness of the plants. This is primarily because the intervention was planned as a monoculture of pine trees, lacking sufficient biodiversity.

The most recent re-vegetation interventions have mostly failed because they are carried out by companies that do not consider the local conditions and the adaptation of plants to the specific site. While a few years ago, plants adapted to the site were produced, in many current situations plants are sourced from nurseries where no adaptation process has taken place, and they struggle to survive.

2. DYNAMIC REFERENCES

In order to intervene in a manner harmonious with the environment, I have examined examples of dynamic processes with elements that undergo changes over time. It is crucial to recognize that in the project, we are not merely dealing with a spatial dimension but also with temporality. Changes occur in the days, seasons, in vegetation and human interventions, impacting variables such as humidity, wind strength, plant growth, human footfall, tides, and more. All these factors influence the project, where we are not just constructing a static landscape but also devising strategies that will adapt as environmental conditions evolve.

Local vegetation, as a living entity, is an integral part of the landscape, aiding in its regeneration. If unsuccessful, it degrades and becomes nutrients for subsequent plantings. Some plants survive by self-protection, capturing moisture from the dew, dispersing, and growing concurrently with dune expansion. Others collaborate to ensure survival. Simultaneously, some illustrate the consequences of planting in unsuitable locations or adapting to wind and humidity based on the landscape's characteristics.

Intervention projects in dune environments are extensively documented, and there is even a Spanish national manual for interventions in these environments (*Manual de restauración de dunas costeras. Ministerio de Medio Ambiente. Dirección General de Costas, 2007*). This manual provides explanations to understand the terrain's morphology, ecological aspects of these environments, and their vulnerability. It also offers recommendations and guidance for selecting appropriate vegetation, methods for propagation in nurseries, and subsequent maintenance.

Moreover, the manual comprehensively covers various constructions within the studied environment, from walkways for crossing dunes to protection systems and sand collection methods for dune reconstruction, all of which facilitate the establishment of vegetation.

The insect that attacks pine trees belongs to a family of beetles, some of which possess unique water management capabilities during droughts. For instance, the Stenocara Gracilipes (Fig. 2) beetle buries itself and slightly cools its body to create micro-condensation effects on its adapted body, enabling it to extract and consume water from the air.

After studying water catchment, another crucial element within the project is the wind. It creates fascinating interactions among the dunes, buildings, and vegetation, making it an important factor to consider when experimenting with the project's possibilities. Behind the constructions, a significant turbulence is generated. This turbulence prevents sediment to be settled down in the area immediately behind the buildings. We can assume that the houses create the effect of highly pronounced dunes, resulting in a distinct interdune space behind each house.

The pathways connecting the road parallel to the shore with the dunes cause a decrease in wind speed beneath the dunes and lead to sediment accumulation around them. Evidently, the turbulence under the walkways sculpts the dunes, creating a "tube" effect beneath them.

Within the project, one tool for understanding the wind, and how to work with it, has been to look at how kites work. Kites are structures

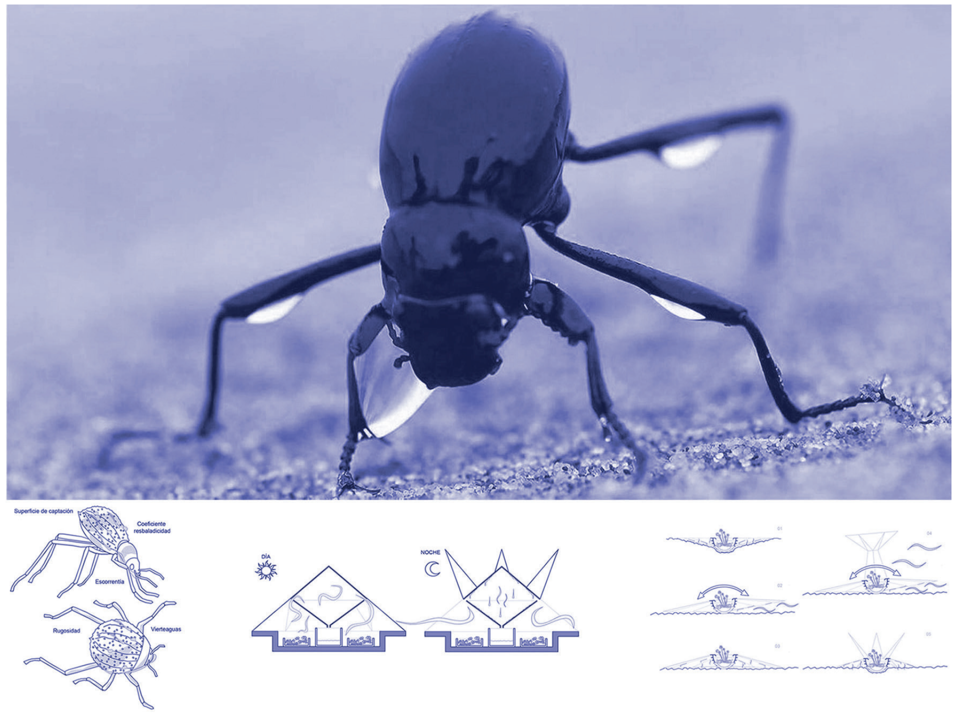

Fig. 2 – Study of water condensation on extreme climatic environment. Water condensation on a desert beetle´s shell, diagrams of greenhouse water and designs for a water condenser pot to introduce on the landscape project.

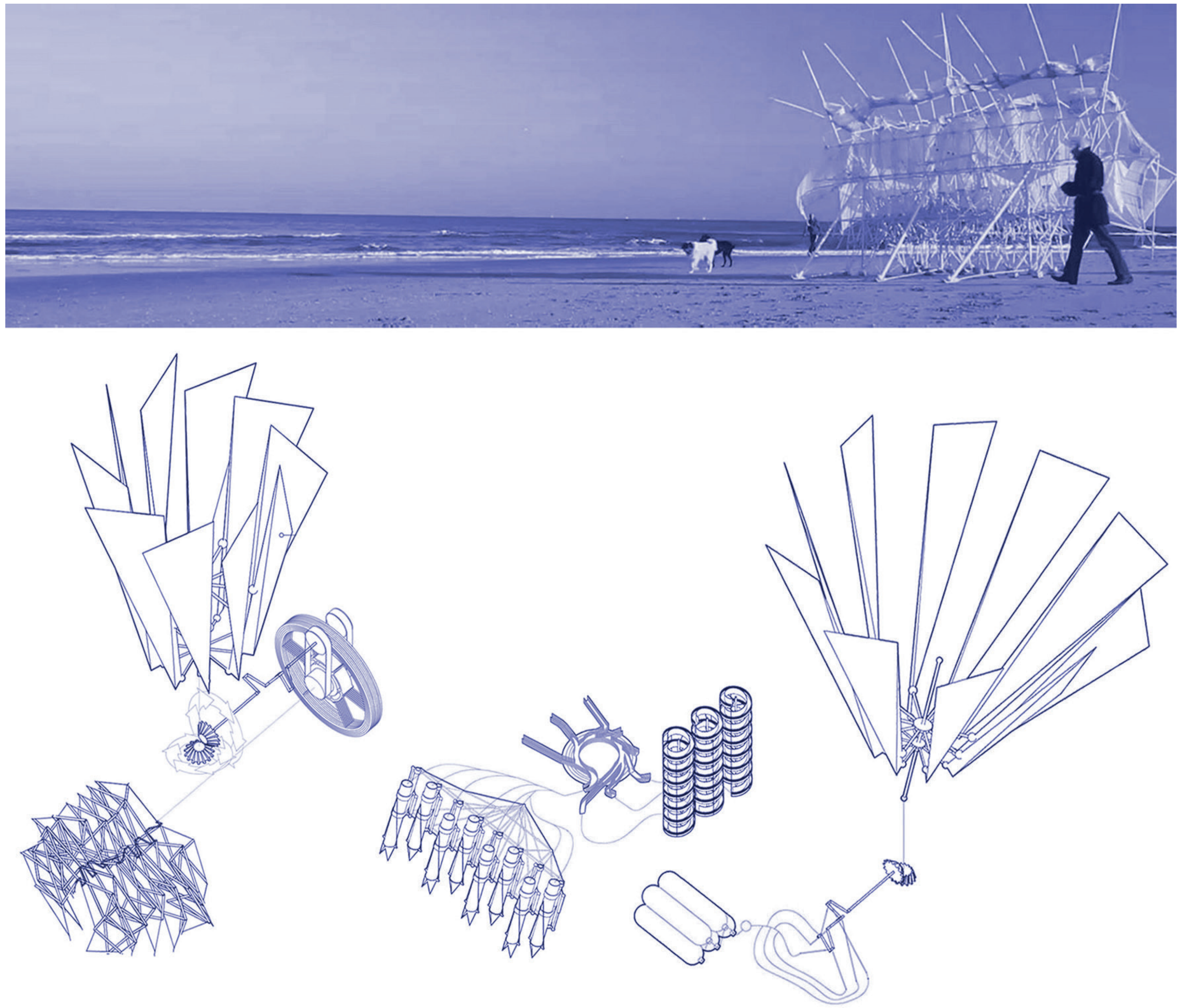

Fig. 3 – Image of Theo Jansen's StrandBeests, and drawings of our theorical designs to adapt his work to the project "A landscape in the air".

designed to harness the wind's power to support themselves, serving as an example of a structure adapted to dynamic forces. They strike a balance between being light and flexible enough to catch the wind and soar, yet rigid enough to withstand the forces of flight. The National Aeronautics and Space Administration (NASA) makes use of kites to explain basic aeronautical principles, and their work with digital wind tunnels aids our understanding of the various components.

On the NASA website, there is a section explaining basic concepts of aeronautics and aerodynamic forces. The site encourages experimentation and understanding of these concepts in practice, even with something as simple as kites. Furthermore, exploring the web tools available, we discover a kite modeller. We use this tool and the data it provides, along with experimenting with various shapes, to design elements for dispersing seeds and plants in our landscape.

All of this informs the design process, enabling us to propose elements that can detach from fixed structures, take flight depending on wind strength, and actively interact with the landscape using their inherent capabilities. We leverage the force of the wind to disperse and deposit them in the dune landscape.

2.1. Theo Jansen, StrandBeests

The Dutch artist Theo Jansen began designing the StrandBeests (Fig 3.) in the late 1980s with the intention of creating creatures to care for local beaches by intervening in the process of sedimentation and utilizing the power of the wind for their function. Over time, these 'beasts' have evolved to incorporate organs and brains that interact with the air, offering insights into the functionality of my own dynamic structures.

Brains of the StrandBeests are powered by a system resembling pneumatic transistors, effectively a compressed air nervous system. Each 'neuron' consists of two air inlets and one outlet, incorporating an inner piston as a valve. This forms a minimal dynamic system comprising three neurons, all of which continuously change their states.

The muscles responsible for moving various parts of the beasts are essentially compressed air pistons that extend and retract. These muscles indirectly drive the locomotion system; their function is akin to pushing the machine against the ground to initiate movement or change direction.

Its locomotion system itself is a complex arrangement of legs, which can be seen as an evolution of the wheel. These legs transform circular motion into a different trajectory, resembling a very flat ellipse that maximizes surface contact with the ground, ensuring superior traction. To achieve this transformation, the initial leg design underwent a deliberate evolution through mathematical and computer-based processes. The outcome yielded what Theo Jansen aptly termed 'magic numbers,' representing the optimal measurements for each leg component to facilitate this motion transmission. These unique legs and their distinctive method of movement are among the most recognizable features of Theo Jansen's project.

The wings of the StrandBeests serve as a means of propulsion. Initially, these limbs were mechanically linked to the locomotion system, with wing movement driving the motion of the legs. They would only move when there was wind. However, as the StrandBeests evolved and developed internal systems, the wings took on a new role. They propelled air through piston pumps into bottles, effectively 'processing and digesting' the wind to generate energy for various internal organs. This linking of energy capture and utilization now occurs pneumatically, rather than mechanically.

To ensure the machines' ability to function autonomously, sensors were developed to connect them to their environment. These sensors include detectors to assess ground consistency (parts in the feet that detect whether the ground is soft or solid), sensors to determine proximity to water and potential risks of becoming stuck, and others capable of detecting excessive wind, indicating storm danger. Additional limbs can be engaged to stabilize the machine and prevent tipping in high winds. All of these systems, albeit rudimentary, rely on components constructed from tubes and compressed air, forming an interconnected network up to the brain. This network functions as a nervous system that becomes increasingly complex and sophisticated with each evolution, aiming to maximize autonomy and enhance the chances of survival in the future. Building upon the organs and biology of the StrandBeests, the project incorporates an adapted evolution of these creatures (Fig. 3).

In this project, new organs have been introduced to enhance their autonomy. Utilizing the wind, they can independently generate air pressure reserves. Alternatively, by employing clutches and gears, they can accumulate enough pressure to propel themselves directly on air, functioning as a 'direct gear.'

Additionally, new functionalities have been developed, including a planting trolley. This trolley, powered by StrandBeests mechanisms, employs gear systems, pistons, and pressurized air to perform planting work in the landscape. Its purpose is to create natural structures in the form of paths or dune barriers.

3. ELEMENTS OF "A LANDSCAPE IN THE AIR" PROJECT

The project is centred around adapting to a dynamic environment, which undergoes spatial and temporal changes driven by various natural and human processes such as wind, tides, vegetation, humidity, sand, infrastructure, and other structural impacts. Structures are designed to inhabit, evolve, and even decay within the landscape. The adaptation of these elements may result in success, they may survive, be transformed, completely change, or disappear. Temporality, mirroring the natural life of the environment, plays a pivotal role in determining the project's success or failure in finding its place in the landscape. Much like a seed lying dormant until the conditions of humidity, aeration, and temperature are conducive to growth or decay, the project will either evolve and integrate seamlessly into the landscape or fade away as if it had never been there.

4. REGENERATING TREE

This piece is designed to integrate the intervention seamlessly into local dynamics in a continuous and cyclical manner (Fig. 4). It utilizes materials with greater longevity and incorporates plant structures for intervention activities. The piece autonomously constructs mesh networks where plants will grow, later dispersing them throughout the landscape, contributing to its self-reconstruction.

The piece nurtures vegetation by providing a humid environment at its base, facilitating plant growth for the elements that will eventually take flight and disperse throughout the landscape.

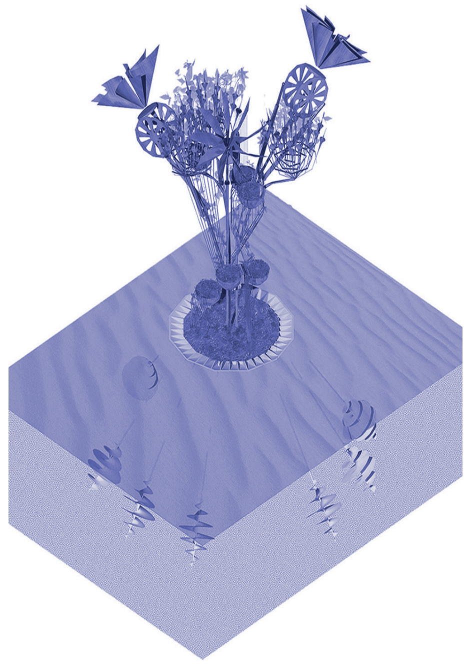

Fig. 4 – Regenerating Tree.

On days with strong winds, these plants are carried into the air, with the most successful ones landing in areas where they can enhance the landscape. They help capture moisture for surrounding plants and contribute to dune growth by trapping sand. The intervention achieves self-reconstruction over time by employing mechanisms and wind energy to supply and store pneumatic energy for these functions. While these plants are part of the tree, they contribute to transitional constructions, generating cool and shaded spaces within the environment.

4.1. Dynamic breakwater

TThe dynamic breakwater shares functions similar to the regenerative tree, but it also interacts with the tidal dynamics that have been previously altered by the breakwater itself (Fig. 5). One of the most critical aspects of sedimentation cycles is the impact of storms, which carry away excess sediment from the beaches, leading to gradual sand loss. To mitigate this dynamic and reduce the impact of strong winds on the beach, an apparatus designed to protect plants from wind would be activated during excessive wind conditions. It would submerge into the sea to calm the currents and counteract the effects that severely erode the beach during the most aggressive sea conditions.

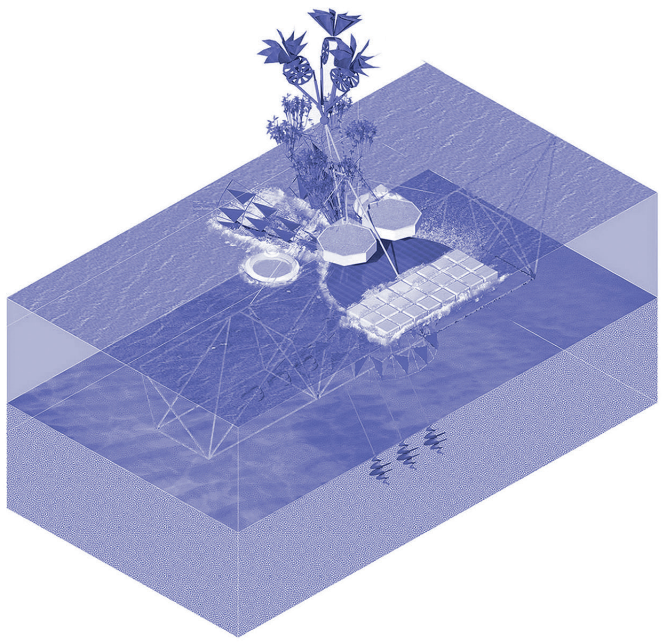

Fig. 5 – Dynamic Breakwater.

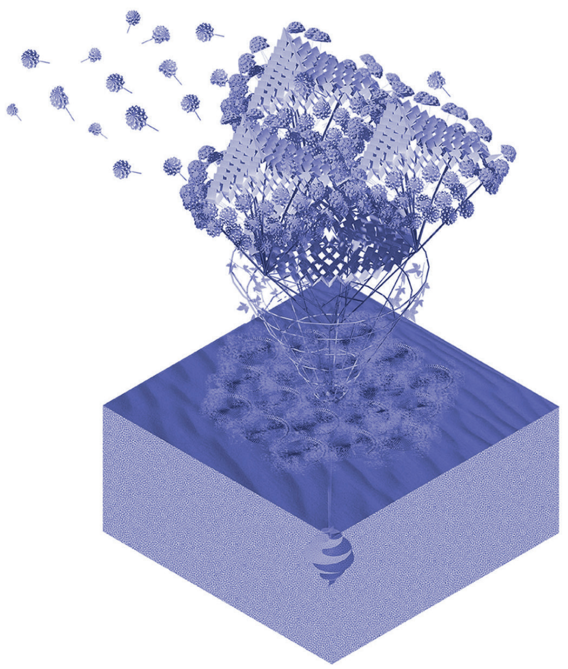

Fig. 6 – Deciduous Tree.

As it changes its position, this structure would expose the plants, allowing them to disperse and contribute to revegetating the landscape, while also playing a role in regulating humidity uptake, dune stabilization, sedimentation, and other related processes.

4.2. Decidous structure

This intervention would be constructed like StrandBeests, specially adapted for this purpose, continuously traversing the landscape and rebuilding it with each changing season (Fig. 6). The piece comprises several components, resembling those of a plant: a base, a stem, and a canopy.

The base serves as a water collector and anchors the structure to the ground. It generates a small condensation effect within, which is utilized to nurture the growth of plants inside and improve soil humidity for neighbouring vegetation to capture.

The canopy is gradually shed in response to the force of the wind, aiding in the dispersal of seeds enclosed within these pieces throughout the landscape. This colonization process leads to various beneficial effects, including enhancing soil humidity, enriching the substrate, stabilizing dunes, and contributing to the sedimentation process where the wind carries these pieces away. The smaller components are carried by light winds, while the larger ones are dispersed by occasional but recurrent strong gales in the landscape.

4.3. Landchap bower

The primary function of this massive beast is to construct and embed the deciduous structures within the landscape. It houses

disassembled pieces compactly within its body, and as they traverse through its internal mechanism, the structures are fabricated on a living assembly line. Its mission involves the continual reconstruction and maintenance of the landscape until a point of equilibrium is achieved, allowing human and natural dynamics to coexist and mutually benefit. These beasts would navigate through the landscape, intervening in locations they deem suitable, such as interdune spaces, established paths, or previous interventions. The creature carries sufficient materials and energy to sustain itself autonomously for a duration, enabling it to return to its point of assembly to resume its work.

In the evolution from the StrandBeests designed to function in our dune environment, I propose a transmission system that combines several concepts to facilitate movement in this complex setting. We will incorporate an energy accumulation system to directly power the legs pneumatically. Additionally, there will be a direct transmission of movement from the wings to the legs when the machine gains enough inertia and can move using wind energy. We will also introduce a flywheel that can store kinetic energy for use when the beast needs to overcome a slope or initiate movement. These three systems (wings, flywheel, and legs) will operate independently but can assist each other pneumatically or mechanically through a system of clutches and transmissions.

To harness wind energy efficiently, we have made slight modifications to the wing design. The wings will move radially, allowing them to capture wind from any direction as they follow a more variable path than the original creatures. Furthermore, the wings will have joints to adjust the radius of the circular motion. By altering their position, they can adapt to light or strong winds. In a wider configuration, they will have greater inertia and capture more air, while in a more closed configuration, they can operate more slowly in strong winds to avoid overloading the pumping system. This system will be coupled to a transmission system that pumps air into the stomachs, where the energy is processed and distributed to the animal's various systems.

One approach to how the beasts will interact with the landscape involves deploying a system for dispersing elements across the terrain, particularly vegetation, in a consistent manner over time, depending on environmental conditions. This system consists of accumulating these elements, assembling them in a somewhat random manner, and utilizing a tool for planting the vegetation. While this concept is still in its early stages, the idea is to equip the beasts with everything necessary for the continuous landscape reconstruction process. In the project, this last evolution called Landchap Bower MkIII (Fig 7) is the one that would live at the dunescape.

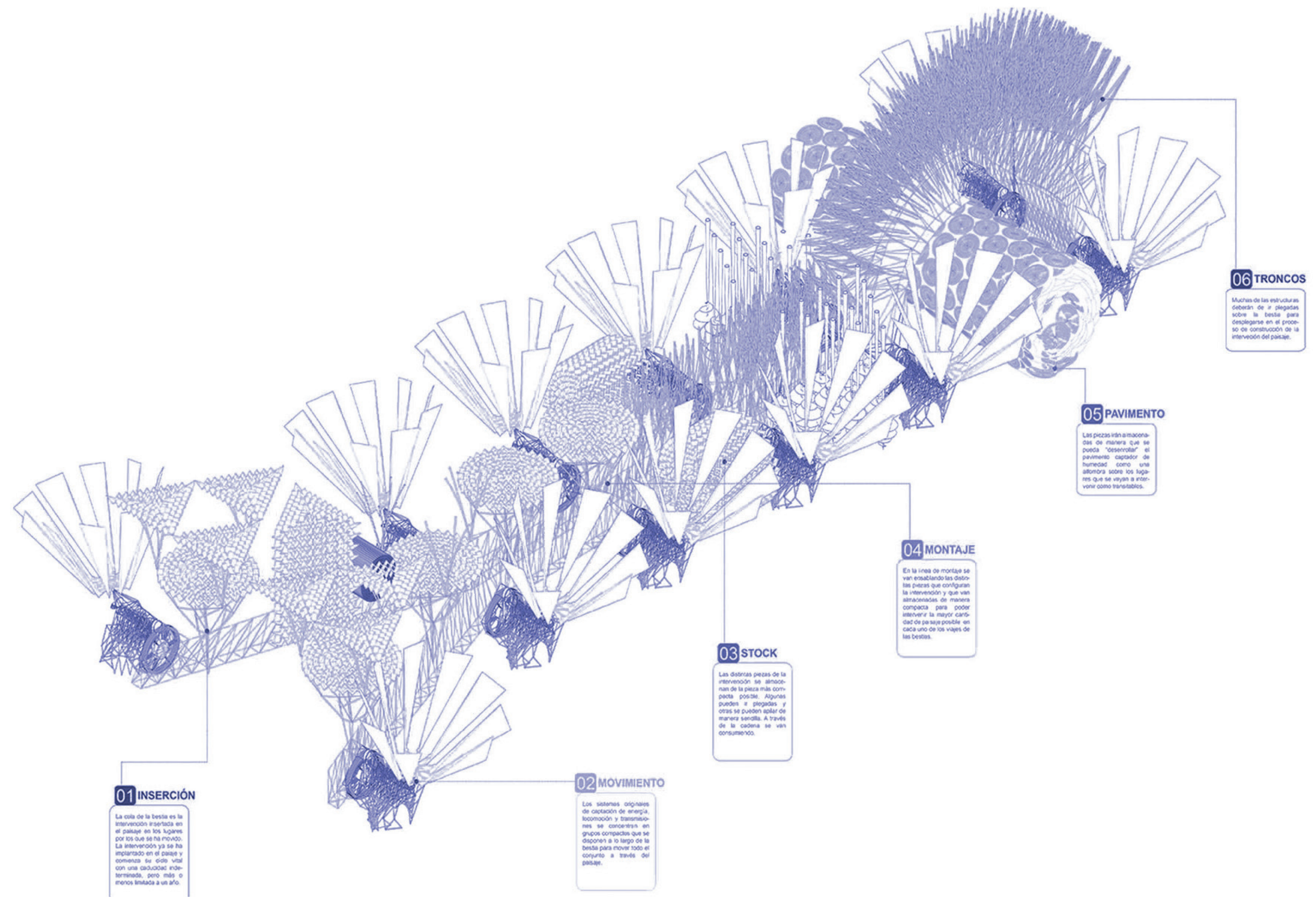

Fig. 7 – Landchap Bower MkIII.

Fig. 8 – Infographic of the landscape built with the dynamic trees adapted to the dune environment.

One approach to how the beasts will interact with the landscape involves deploying a system for dispersing elements across the terrain, particularly vegetation, in a consistent manner over time, depending on environmental conditions. This system consists of accumulating these elements, assembling them in a somewhat random manner, and utilizing a tool for planting the vegetation. While this concept is still in its early stages, the idea is to equip the beasts with everything necessary for the continuous landscape reconstruction process. In the project, the latest evolution, known as Landchap Bower MkIII, is designed to inhabit the dunescape, moving in response to the intensity of the wind. Its purpose is to create a landscape featuring self-sustaining vegetation paths and dynamic trees, establishing connections and integrating spaces for human use, such as the port or urban areas, with the beach, dunes, and forest.

4.4. Evolution of the project in the landscape

The Landchap Bower MkIII traverses the landscape, selecting suitable locations for the installation of these structures. It harnesses its own energy to enhance its autonomy, and its body and limbs are designed for movement through the dunes. This great beast serves as a generator of structures and dynamic trees (Figs. 8 and 9) that must colonize the landscape, adapting to the site's requirements or fading away.

The initial implantation is aggressive, capitalizing on existing features like paths, walkways, and revegetation areas, like static interventions. This has implications for the site, but over time, these impacts are softened as the project adapts to the environmental balance.

With the passage of time, the implantation has evolved. Some structures and purposes endure, while others are lost. The deciduous structures continue to shape pathways intertwined with the vegetation they've nurtured. Certain aerial components have thrived, introducing humidity, providing shaded spaces, or stabilizing dunes where the wind has deposited them. Protections and boundaries vanish as vegetation itself defines spaces, preventing cyclical degradation while maintaining areas for leisurely walks and enjoyment of the landscape (Fig. 10).

As a conclusion to this article and the project's process, I like to envision the possibility of working differently. Our current approach involves constructing rigid, immutable, permanent, and inert environments using materials like concrete, asphalt, steel, glass, etc. However, there is an alternative, we can also work with time,

Fig. 9 – 1:1 scale model of the dynamic trees by Iván Torregrosa, at the Alicante School of Architecture as part of his Final Project.

embrace perishable processes, and incorporate living or dynamic elements into our projects.

In an ideal future, this project will evolve, change, and eventually expire. Pieces carried by the wind will find their place, undergoing evolutionary processes within the landscape. They will generate spaces, alter topography, and influence the humidity or temperature of the areas they colonize. Protections and boundaries vanish as vegetation itself defines spaces, preventing cyclical degradation and leaving room for transit and the enjoyment of the landscape. Over time, many of these elements will fade, making way for unforeseen ones.

This evolution ensures that the initial project becomes unrecognizable, mirroring the life cycle of any living being in nature, born, changing, reproducing, evolving, and eventually passing away.

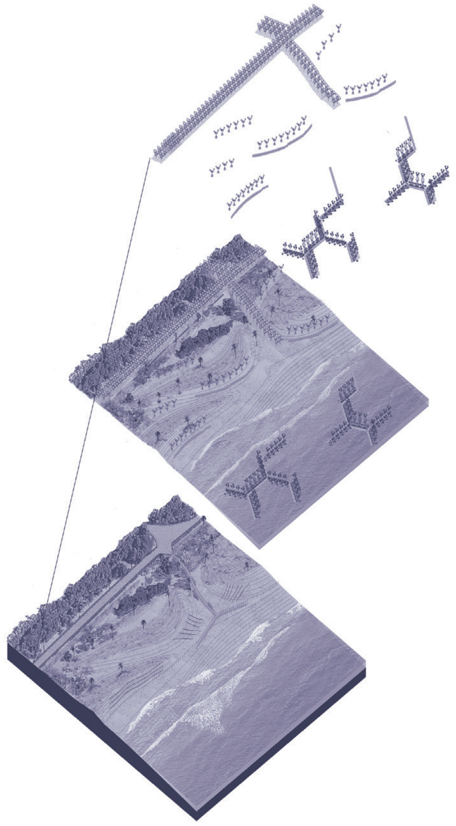

Fig. 10 – Landscape implantation with the dynamic strategy.

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