Mix Sustentável

Platalea ajaja: Urban Pruning Wood Bioinspired Utensils

Platalea ajaja: Utensílios Bioinspirados de Madeira de Poda Urbana

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Abstract: This article addresses the use of tree waste from pruning and urban suppression to make kitchen utensils that allow the construction of a cultural identity of Bertioga. Thus, an approach of biomimetic and biomorphic concepts was used from the spoonbill bird *(Platalea ajaja)* to conduct the project. In order to offer a product that local artisans could manufacture and have an artisanal culture valued, concepts of circular economy, regenerative design, slow design and design and territory were also used in the literature review. Following the double diamond method, the development of the project started from the analysis of the history and caiçara culture of Bertioga, as well as the osteological study of the bird, and disrupted a traditional carpentry production, with the application of

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natural dyes and finishes, so that the arts could replicate the prototypes without great difficulties.

Keywords: Sustainability; Biomorphism; Brazilian design; Urban pruning wood; Utensil design.

Resumo: Este artigo aborda o uso de resíduos arbóreos provenientes da poda e supressão urbana para confecção de utensílios de cozinha que permita a construção de uma identidade cultural de Bertioga. Assim, utilizou-se uma abordagem de conceitos biomiméticos e biomórficos a partir da ave colhereiro *(Platalea ajaja)* para conduzir o projeto. A fim de oferecer um produto que os artesãos locais pudessem fabricar e ter a cultura artesanal valorizada, também foram utilizados na revisão de literatura conceitos de economia circular, design regenerativo, slow design e design e território. Seguindo o método double-diamond, o desenvolvimento do projeto partiu da análise da história e cultura caiçara de Bertioga, bem como do estudo osteológico da ave, e seguiu uma produção de marcenaria tradicional, com aplicação de tinturas e acabamentos naturais, de modo que os artesãos pudessem replicar os protótipos sem grandes dificuldades.

Palavras-chave: Sustentabilidade; Biomorfismo; Design brasileiro; Madeira de poda urbana; Design de utensílio.

Resumen: Este artículo aborda el uso de residuos arbóreos provenientes de la poda y el desmonte urbano para crear utensilios de cocina que permitan la construcción de una identidad cultural para Bertioga. Por lo tanto, se utilizó un enfoque biomimético y biomórfico, basado en la espátula rosada (*Platalea ajaja*), para guiar el proyecto. Con el fin de ofrecer un producto que los artesanos locales pudieran fabricar y que valorara su cultura artesanal, también se utilizaron en la revisión bibliográfica los conceptos de economía circular, diseño regenerativo, diseño lento y diseño y territorio. Siguiendo el método del doble diamante, el desarrollo del proyecto comenzó con un análisis de la historia y la cultura del pueblo Caiçara de Bertioga, así como un estudio osteológico del ave, y siguió un proceso de producción de ebanistería tradicional, con la aplicación de tintes y acabados naturales, para que los artesanos pudieran replicar los prototipos sin gran dificultad.

Palabras clave: Sostenibilidad; Biomorfismo; Diseño brasileño; Madera de poda urbana; Diseño de utensilios.

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1 INTRODUCTION

The issue of climate change affects not only a single country or region but the entire planet, with one initially isolated factor affecting others and consequently unfolding in a domino effect, whether short or long range, short or long term. As Tavares (2022) discusses together with other authors in "Habitar o antropoceno", global temperature change and its harmful effects are increasingly noticeable in everyday life, slowly moving from a fictional scenario to reality. It is up to scholars worldwide to seek solutions to these problems. In light of this, we can see different types of approaches, whether in the political, legislative, technological, social, or other areas. This article is situated within the field of sustainable design and the valorization of urban waste, seeking to address an existing gap in the literature regarding the systematic use of urban pruning wood for the development of handcrafted products in Brazil. Although there are isolated initiatives related to the reuse of tree waste, there is a lack of research that integrates, in a cohesive way, the axes of bioinspiration, territorialized artisanal production, and circular economy. The choice of Bertioga as the research territory stems from both the significant volume of pruning waste generated in the municipality and the cultural relevance of caiçara communities, as well as the symbolic presence of the roseate spoonbill *(Platalea ajaja)*, which informs the construction of local identity based on a local bioinspiration. This applied and experimental research, developed within the PodaLab/FAU-USP which the authors are part of, aims to explore productive possibilities that connect ecology, culture, and artisanal manufacturing. The project with the artisans began in the course AUT 2503 - Design, Culture and Materiality in 2023, in which the students collaboratively developed prototypes and brands for them. This work sought to continue the initiative of valuing and developing artisanal work through design methods and tools. Thus, proposing a more immediate response to the problem that these materials cause in their decomposition when they are disposed of in landfills: the production of greenhouse gases (methane and carbon dioxide); soil and water pollution from the leachate generated during decomposition; and attraction of pests (Souza *et al.*, 2022). Thus, with the help of design tools, techniques, and theories, the project seeks to develop utensils made from pruning waste, seeking to maintain the identity of Bertioga's local culture through the use of biomimetic and biomorphic concepts based on the spoonbill *(Platalea ajaja)*. It also seeks to stimulate a sustainable economy that benefits local artisans, preserving the artisan culture and reducing the environmental impacts caused by urbanization, since the city of Bertioga, like other coastal cities in the state of São Paulo, has been developing increasingly over the last two decades, expanding its urban area and having the Atlantic Forest preservation areas occupied by the poorest population. This article seeks to address this problem by using pruned wood to provide work for artisans, based on design concepts to create kitchen utensils. To achieve these objectives, the project seeks, as does the research developed by the collaboration be- tween FAU-IPT (Souza *et al.*, 2022), to follow the guidelines of the 2030 SDGs (Nações Unidas Brasil, 2015) established by the UN. Among the various objectives and targets, the project works mainly with target No. 11 of Sustainable Cities and Communities, more specifically, topic 11.6.1 - proportion of municipal solid waste regularly collected and properly disposed of in the total municipal solid waste generated by cities.

To guide the development of the project, this article was based on the concepts of: a) Circular econ-

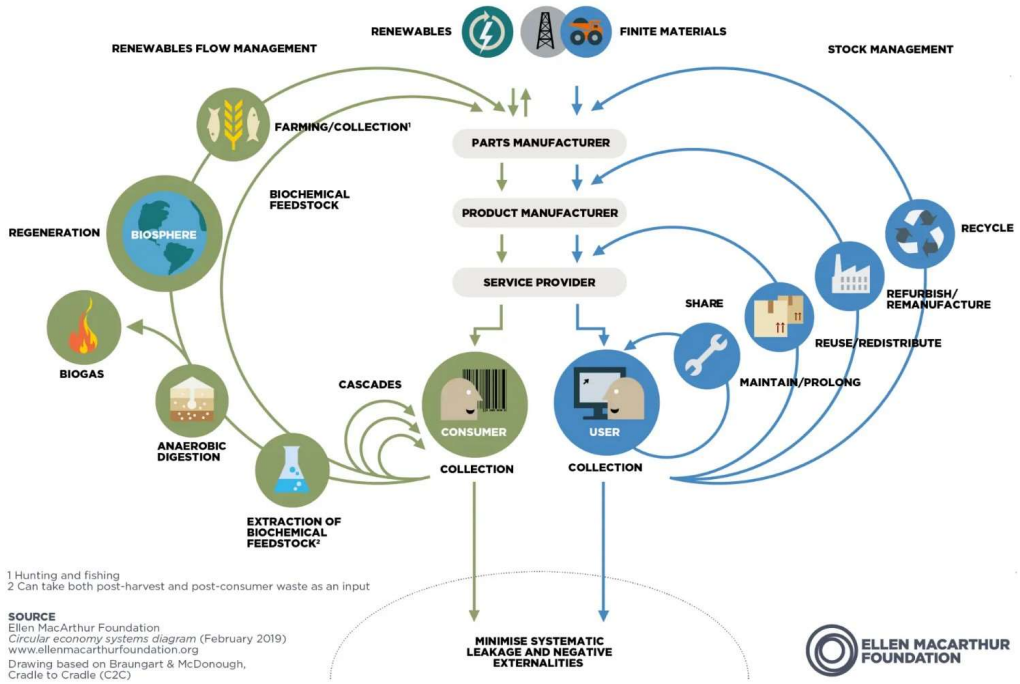
Figure 1 – Identified tree residues from CUASO (Cidade Universitária Armando Salles de Oliveira)

Source: Authors.

omy, which according to Boulding (1966) is an inevitable system in a global economy that depends on finite resources, requiring the establishment of recycling and reuse systems for both natural and technological resources. McDonough e Braungart (2002), during conferences with Walter Stahel in the 1980s, were already promoting the idea of recycling materials in the cradle to cradle model of the 1987 report "Economic Strategies of Durability" by Stahel and Börlin as a reaction to the failure of the linear cradle-to-grave production model, which depended on end-of-cycle solutions and did not address the issue of sustainability in a profound way, arguing that the true solution would be a closed product cycle. The most widely accepted general definition of Circular Economy is given by the (Ellen MacArthur Foundation,), which states that "a circular economy is one that is restorative and regenerative by design and keeps products, components, and materials in their highest utility and value at all times, distinguishing between technical and biological cycles," in which we have the use of finite materials, which are recycled, renewed/remodeled, reused/redistributed, reused/extended, and shared. Meanwhile, renewable materials are extracted and used, and their residues are returned to nature in order to regenerate it, so that they can be generated and used again.

This concept proposes a system in which the residues are never discarded, but reinserted in the productive process, thereby basing it on three principles: 1. The elimination of waste and pollution, that the current economic model is based, the linear process of "take-make-waste" in which the raw material is taken from the natural environment to produce products that at the end of their life cycle are discarded on landfills, making both the organic and inorganic waste pollute the environment, be it by emitting gas or slurry in their decomposition or by their resistance to degradation, where some take hundreds of years to decompose naturally like plastics; 2. Circulation of products and materials by their highest value means that, within a production chain, these elements can be reintegrated into the manufacturing process by reusing the waste generated, thus preventing disposal. This system also incorporates the use of renewable energy sources, as well as practices of recycling,

Figure 2 – Circular economy diagram



Source: <https://www.ellenmacarthurfoundation.org/circular-economy-diagram?_gl=1*1p0uxe*_up*MQ..*_ga*NjM0NDY2NzY0LjE3MTU2NDM4ODk.*_ga_V32N675KJX*MTcxNTY0Mzg4Ni4xLjAuMTcxNTY0Mzg4Ni4wLjAuMA>. Access 10/05/2024.

reusing, and reinterpreting materials, aiming to maximize the value of these resources and reduce dependence on limited raw materials. 3. Regenerating nature, which is directly linked to its restoration, aiming to pre- vent further environmental degradation and negative impacts on ecosystems. It is based on the understanding that a truly prosperous economy can only exist in symbiosis with nature, benefiting all parties involved while respecting the limits of the planet's available resources.

b) Regenerative design and culture, which according to Wahl (2020), consists of creating "cultural systems" that enable regeneration from an ecological, social, and economic point of view through the use of concepts of permaculture, ecology, and social justice, in order to foster societies that develop in harmony with natural patterns (time and form), promoting the health and well-being of all forms of life in the environment. In this sense, the design of cultural systems becomes a tool to restore degraded or threatened ecosystems, promote social equity, and strengthen resilience in the face of ecosocial challenges such as climate change, social inequality, and biodiversity loss. The regenerative culture design system, therefore, seeks to sustain, regenerate, and restore both natural and social resources. It is characterized by: Cultural ecosystem: systems that emulate natural patterns and processes (biomimicry) to foster regeneration and sustainability; Resource cycles: systems that minimize waste and encourage the reuse and recycling of both material and energy re- sources. Social inclusion: promote equity and ensure the participation of diverse groups within the design process; Social resilience: strengthen local communities by fostering autonomy, cooperation, and adaptability;

Cultural and biological diversity: value and enhance both cultural and biological diversity, recognizing it as a key foundation for resilience and adaptation. It is evident that sustainable design shares many principles with regenerative design. However, as Wahl (2020) points out in his book "Designing Regenerative Cultures", there is a significant critique: while sustainable design is valuable, it is not the most suitable approach for addressing today's challenges.

> "Sustainability, in and of itself, is not an adequate goal. The word sustainability itself is inadequate, as it doesn't tell us what we are actually trying to sustain. In 2005, after spending two years working on my doctoral dissertation in sustainability design, I began to realize that what we are actually trying to sustain is the underlying pattern of health, resilience, and adaptability that keeps this planet in a condition in which life as a whole can flourish. Sustainability design is, ultimately, design for human and planetary health." (Wahl, 2006)

In order to create a regenerative culture, Wahl proposes a shift from the use of fossil resources to renewable and regenerative biological resources, as well as to enhance recycling and resource recovery. This transition is crucial given the significant damage human activity has caused to the healthy functioning of ecosystems, particularly over the past century. In this context, Bill Reed outlines several essential changes required to achieve a truly regenerative culture:

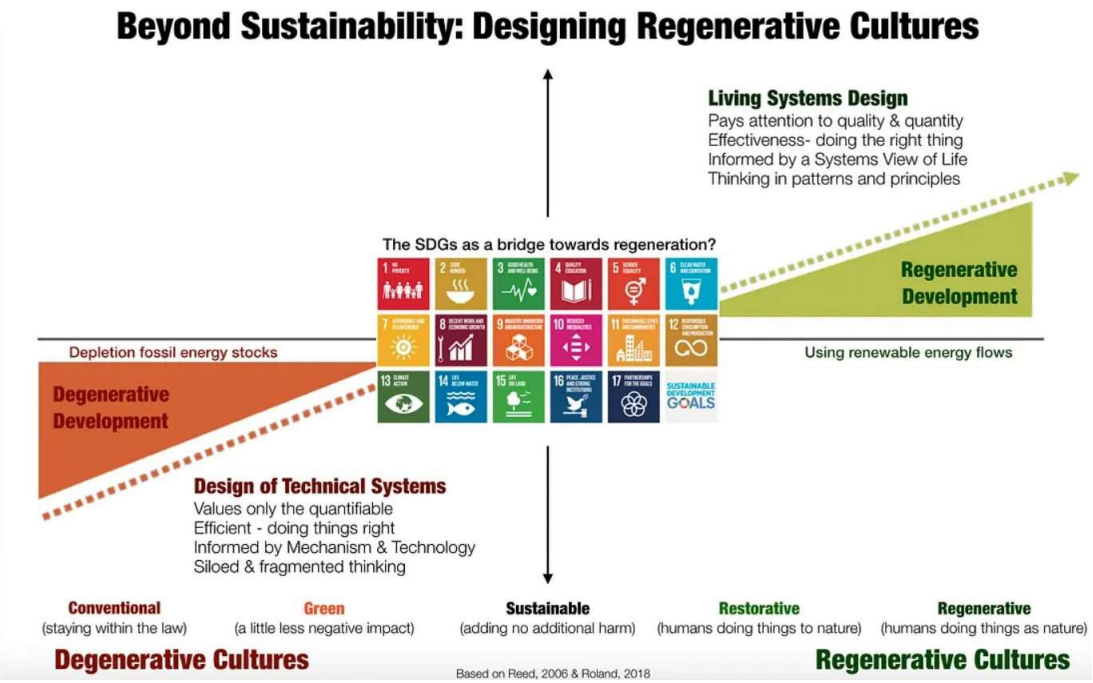
> "Instead of causing less harm to the environment, it is necessary to learn how to participate in the environment —using the health of ecological systems as the basis for design. [. . .] Shifting from a fragmented worldview to a comprehensive systems mental model is the significant move our culture must make—delineating and understan- ding the interrelationships of the living system in an integrated way. A place-based approach is one way to achieve this understanding. [. . .] Our role, as designers and stakeholders, is to shift our relationship to one that creates a whole system of mutually beneficial relationships." (Reed, 2007)

The graph (figure 3) illustrates the progression toward a regenerative system, starting from the current degenerative model, which depletes fossil fuel reserves. This progression represents gradual shifts in perspective, in which human practices increasingly reduce their impact on the environment until reaching the stage of sustainability, where no environmental damage occurs. To reach this stage, it is proposed to follow the United Nations Sustainable Development Goals (SDGs), which serve as a bridge toward regenerative development. This transition requires a shift in mindset, where humanity becomes more actively engaged in the processes of life and in the integration between nature and culture.

Thus, regenerative design aims to create cultures that preserve, protect, and enhance "biocultural abundance", benefiting not only future human generations but all forms of life on the planet (Wahl, 2020). In this way, it becomes a tool for regenerating degraded or threatened ecosystems, promoting social equity, and ensuring a certain resilience to eco-social problems such as climate change, social inequalities, and threats to biodiversity. Thus, the regenerative crop design system aims to sustain, regenerate, and restore both natural and social resources.

c) Slow design, which according to (Strauss; Fuad-luke, 2008), arises from the rejection of excessive consumerism promoted by Western culture, seeking to develop society based on a sustainable economy. This

Figure 3 – Transition from degenerative to regenerative culture



Source:<https://medium.com/age-of-awareness/how-do-you-distinguish-between-regenerative-and-sustainable-design-454c9d1faf20>. Access: 14/05/2024.

requires a comprehensive understanding of design, i.e., understanding everything from the origin of the raw material to the final production of the product or service, taking into account the ethical and social aspects involved and the short- and long-term impacts, whether beneficial or not. Slowness does not refer directly to the time it takes to produce something, but rather to the perception of the actions and experiences of individuals and communities (Slow lab/New York). This holistic view of slow design allows for the development of solutions to current problems or demands based on criticism of the processes and technologies from which they were created, while encouraging the use of the local network, whether of people, materials, or industry, thus preserving them.

Building on these concepts, Strauss and Fuad-Luke outline the principles of Slow Design, which are: 1. Reveal: Slow Design highlights everyday life experiences that are often overlooked or forgotten, including materials and processes that can easily be ignored in the creation of an artifact; 2. Expand: It considers the real and potential "expressions" of artifacts and environments, going beyond their perceived functionalities, physical attributes, and expected lifespan; 3. Reflect: Slow Design artifacts, environments, and experiences encourage contemplation and what slowLab terms "reflective consumption; 4. Engage: Slow Design processes are open-source and collaborative, fostering sharing, cooperation, and transparency of information so that projects can continue to evolve over time; 5. Participate: It encourages users to become active participants in the design process, embracing ideas of interaction and exchange to promote social responsibility and strengthen

communities; 6. Evolve: It recognizes that richer experiences can emerge from the dynamic maturation of artifacts, environments, and systems over time. By looking beyond current needs and circumstances, Slow Design acts as an agent of behavioral change.

d) Biomimicry and biomorphism, the former being an approach that seeks inspiration from nature to solve complex problems in design, engineering, architecture, etc. It is based on careful observation and understanding of biological systems and their fundamental principles to create creative and efficient solutions (Dias, 2014). Biomimetic design is therefore based on the creative process developed by nature. By emulating these natural patterns and strategies, products, systems, and technologies can be developed that are more sustainable, effective, and harmonious with the environment (Munari; Vasconcelos, 2008).

Biomorphism, on the other hand, works with the formal aspect (shape) found in natural structures, using it to compose an aesthetic and visual concept, reproducing natural forms but without incorporating their systemic functions as mechanical and functional principles that are part of the context of the ecosystem to which they belong. According to Pawlyn (2019), from an architectural point of view, biomorphism differs from biomimicry in that it is used as a source of inspiration for unconventional forms and for its symbolic associations.

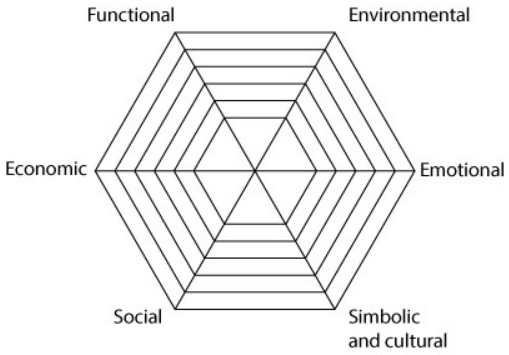
e) Design and territory, according to Krucken (2009), proposes a systemic approach that encompasses both territories and the products and services generated through design. However, this perspective goes beyond the simple creation of objects and services, also encompassing the transformation of spaces and social relations. From a holistic perspective, it allows us to identify the unique characteristics of a territory, such as its culture, history, and society. In this context, design is a tool capable of promoting the inclusion and participation of inhabitants, seeking solutions that value local culture and identity. In this process, the designer plays the role of collaborator and/or mediator, identifying the needs and demands of the community and understanding the attributes of local products and their meanings, contributing to the revelation of the values and qualities of intangible cultural heritage.

In order to achieve these goals, tools and initiatives such as the “value star” are used to assess various quality dimensions that influence consumer purchasing decisions and their perception of product or service quality.

The value dimensions proposed by Krucken are divided into: 1. Functional or utilitarian value: evaluates objective attributes related to the adequacy and efficiency of the product in use; 2. Environmental value: considers the product’s environmental performance, particularly regarding the sustainable use of natural resources; 3. Emotional value: a subjective dimension that connects affective motivations with sensory perceptions associated with the product; 4. Symbolic and cultural value: relates to the product’s significance within specific production and consumption systems, reflecting traditions, cultural meanings, and the expression of social identity; 5. Social value: links the production process to social aspects, such as inclusion, well-being, and benefits provided to local communities; 6. Economic value: evaluates the cost-benefit relationship from a monetary perspective, considering the balance between price, performance, and durability.

f) Wood from pruning and removal in urban areas, referring to trees in the urban environment, which, when pruned or removed due to some type of complication, generate a large amount of waste. The IPT research

Figure 4 – "Value star" - Value dimensions of products and services



Source: Krucken (2009).

in partnership with other authors: "Urban tree pruning waste: how to reuse it?" (Souza *et al.*, 2022), presents data that, according to the São Paulo City Hall (PMSP), the state collects about 4,000 tons of waste per month, reaching up to 50,000 tons per year. The Bertioga City Hall (PMB), in 2016, collected 180 tons per month, reaching about 2,000 tons per year. In Bertioga alone, in 2020, the Bertioga Municipal Environmental Database recorded that 70 trees fell during the year, but that 357 were also planted.

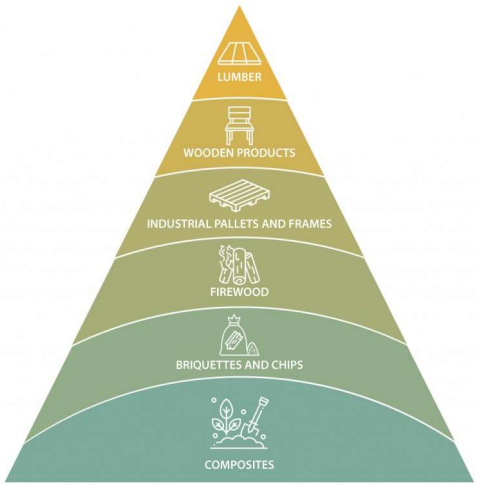
Furthermore, in 2022, the SNIS (National Sanitation Information System) also showed that all types of solid waste in Brazil are still mostly sent to dumps and landfills, costing around R$ 30 billion annually. The article presented here proposes precisely to try to transform these "polluting expenses" into "sustainable expenses," allocating the use of this material for social benefit rather than damage, which affects not only humanity but the entire planet's ecosystem.

To optimize the use of pruned urban wood, the PodaLab research group developed a hierarchy of applications. At the base are residues, such as leaves, used for organic compost, briquettes, and wood chips, which are compacted under high pressure without chemical additives. Next comes firewood, which can be used in restaurants or as fuel; pallets, employed for stacking and transportation; wood products, such as furniture, utensils, and toys; and, at the top, sawn wood, which can be processed into various sizes and applications.

To make this hierarchy feasible within a circular economy framework, it is recommended to adopt the cascade use principle, which promotes the sequential and consecutive use of resources, prioritizing: The most valuable use of natural resources; Minimal consumption of inputs and energy during transformation into products; Maximum reduction of waste throughout the production and use phases; Extended durability of materials to slow down degradation.

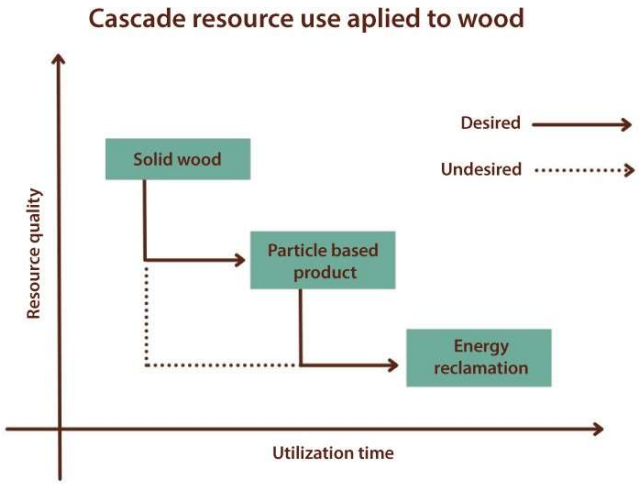
In the case of pruned wood, this approach helps prevent "downcycling", meaning any process that would reduce the material's value or shorten its life cycle. Among the species found in Bertioga, the IPT research studied the parasol palm *(Terminalia catappa)* and the straw palm *(Clitoria fairchildiana)*, but highlights that the species with the greatest abundance and greatest need for pruning also include the Benjamin fig *(Ficus benjamina)* and the jerivá palm *(Syagrus romanzo*fl*ana)*. All are suitable for the production of utensils, with the exception of the jerivá palm, which is used in landscaping and gastronomy. Bertioga's urban forestry guide

Figure 5 – Hierarchy of uses and applications of urban pruning wood



Source: <https://sites.usp.br/podalab/fundamentos/>. Access: 09/06/2024.

Figure 6 – Cascading use concept applied to wood

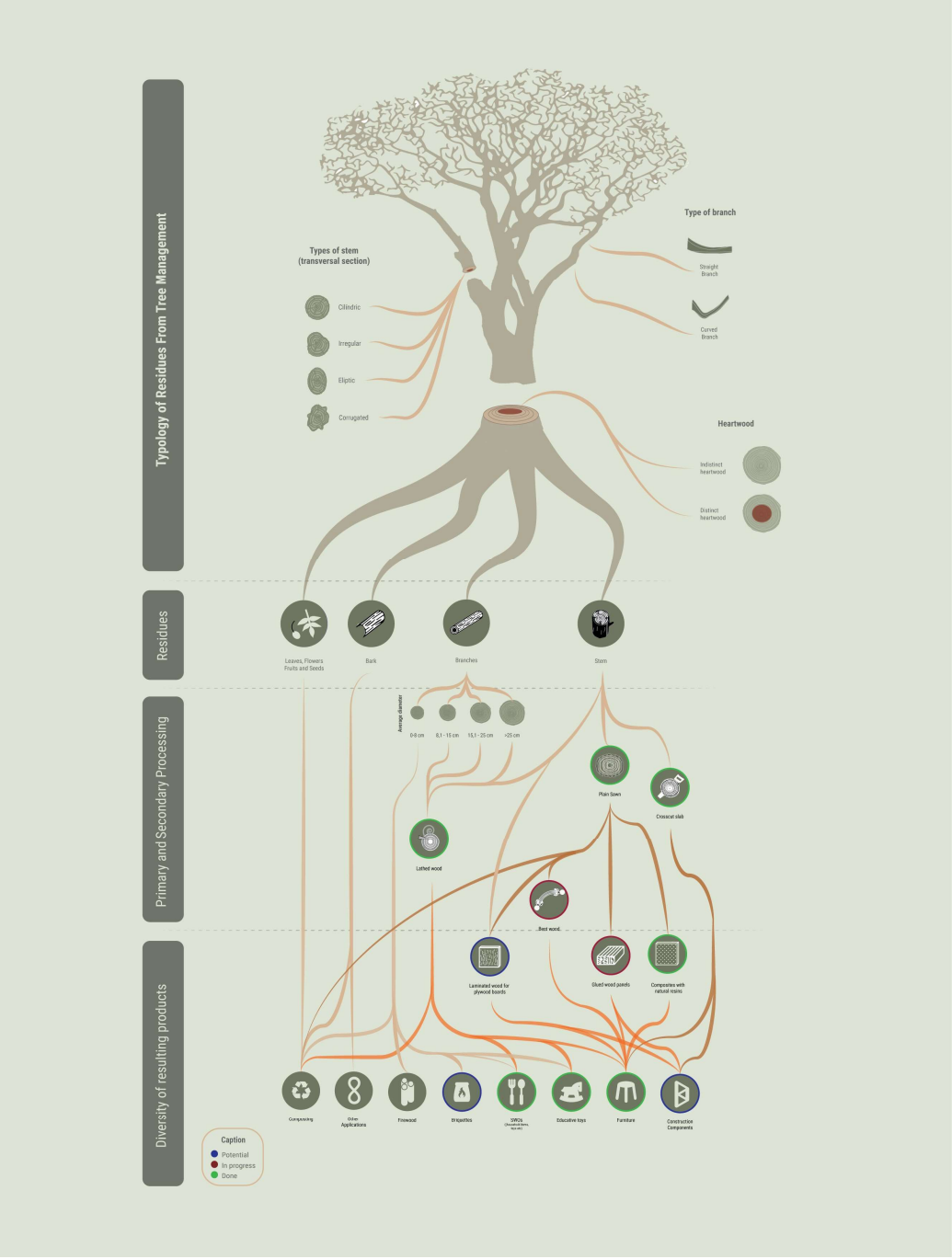


Source: <https://sites.usp.br/podalab/fundamentos/>. Access: 09/06/2024.

(Prefeitura Municipal da Estância Balneária de Bertioga (PMB), 2017) also lists other species present in the city, including: Beach cotton *(Hybiscus pernambucensis)*, Aroeira *(Schinus terebinthifolius)*, Bottlebrush *(Callistemon sp.)*, False mamery *(Calophyllum brasiliensis)*, Brazilian Orchid Tree *(Bauhinia forticata)*, Brazilian Ironwood *(Caesalpina ferrea)*, Purple Glory Tree *(Tibouchina granulosa)*, White Ipê *(Tabebuia roseoalba)*, Yellow Ipê *(Tabebuia sp.)*, Purple Ipê *(Tabebuia heptaphylla)*, and Pink Ipê *(Tabebuia pentaphylla)*.

The overall objective is to develop an experimental product design, containing a family of products based on the use of urban pruning and removal wood and the application of biomimetic and biomorphic concepts. The specific objectives are: a) To identify the possibilities for creating utensils based on the spoonbill

Figure 7 – Mapping of design-driven technology routes for af-forestation management waste (credit: F. G. Melo, 2022)



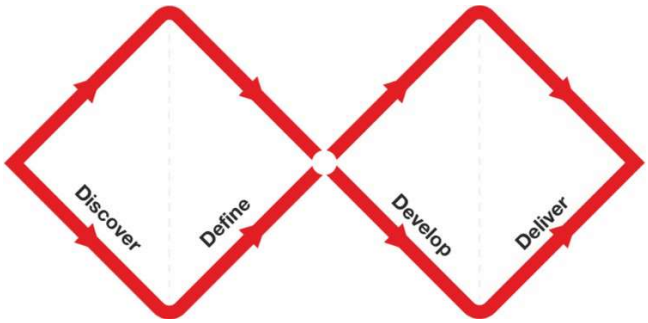
Source: "Urban forests management. Design-driven technological routes for wood waste valuing".

(Platalea ajaja), defining the requirements and conceptual aspects of the bird; b) To propose a manufacturing method that follows traditional carpentry techniques and tools; c) To design based on references, manual drawings, and 3D scans; d) Identify and collaborate for the preservation of local craft culture.

2 METHODOLOGICAL PROCEDURES

The proposed work is practical, experimental, and laboratory-based product design, using resources such as digital modeling and urban pruning wood to gather and generate knowledge through literature review and experimentation with traditional subtractive woodworking techniques. For this purpose, urban pruning wood from CUASO (Cidade Universitária Armando Salles de Oliveira) available at STMEEC (Technical Section of Models, Tests, and Construction Experiments) of FAUUSP and software such as Fusion 360, Blender, the ADOBE package in general, and others were used. The methodological structure of the article is divided into: a) An unsystematic review of the literature consists of gathering concepts related to the theme that were important for the development of the project, thus covering the concepts of circular economy and sustainable design, regenerative culture design, slow design, biomimicry and biomorphism, design and territory, and urban pruning and removal tree waste; b) Data collection on Bertioga, caiçara culture, Brazilian handmade utensils, and the spoonbill *(Platalea ajaja)*; c) Defining mandatory and desirable requirements; d) Study of the shape of the spoonbill's skull, beak, and jaw and their adaptations for wooden kitchen utensils; e) Experimental production of utensils on a 1:1 scale using traditional carpentry techniques, with the shape as similar as possible to the original reference; f) Creation of sketches of the utensils based on wooden models faithful to the original shape of the bones; g) Selection of the designs that best fit the requirements and have the greatest production feasibility; h) Planning and final production of the utensils from the selected designs on a 1:1 scale using digital and traditional woodworking techniques. The design method used to guide the development of the work was the Double Diamond, developed by the UK Design Council, which is a method that aims to enhance the processes of innovation in design in four phases: Discover, Define, Develop, Deliver (Brown, 2010), as shown in the image below.

Figure 8 – Double-diamond diagram



Source: <www.designcouncil.org.uk/our-resources/the-double-diamond/> . Access: 07/06/2024.

The methodological structure of the article fits within these four phases, as follows: a) Discover: Containing the research stage; b) Define: Containing the stages of requirements, formal investigation, and initial prototyping; c) Develop: Containing the stages of drafts and improvements; d) Deliver: Containing the final stages of selection of alternatives, modeling, and final prototyping.

3 APPLICATIONS AND RESULTS

The development of the work is divided into: a) Research, addressing the context and history of Bertioga and the caiçara culture, Brazilian handicrafts, the spoonbill *(Platalea ajaja)*, microplastics and natural dyes; and b) Project activities, which consist of defining requirements, formal analysis, drafting, and prototyping.

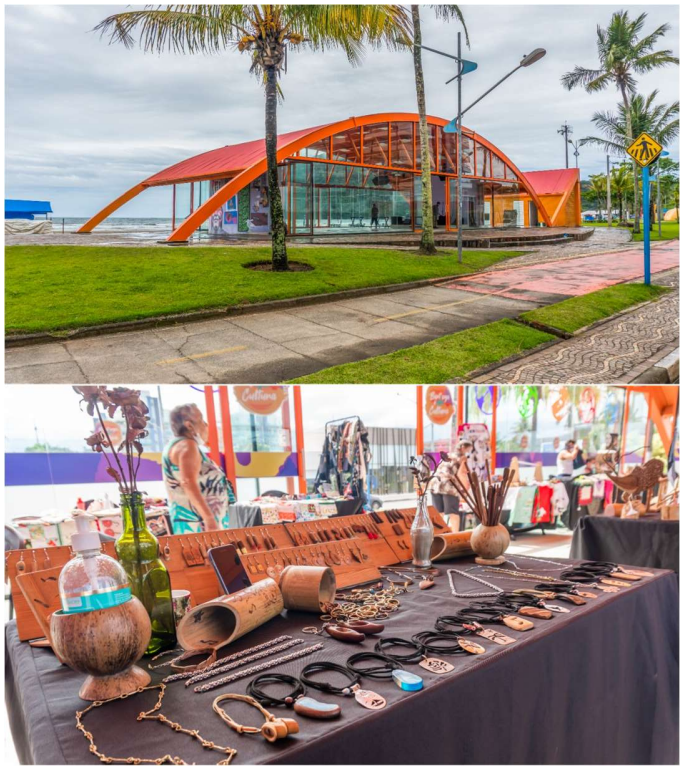
3.1 Research of cultural, biological and material aspects

The research topic covers data on the context and history of Bertioga and the caiçara culture, provided by the PMB (Bertioga City Hall) and Sabino (), as well as Brazilian handicrafts in order to understand current socio-environmental problems, cultural aspects, artisanal activities to propose a solution. It also covers aspects of the spoonbill *(Platalea ajaja)*, to assist the bioinspiration concept applied to utensils; microplastics, for the purpose of justifying the use of wood in utensils, a material that is less harming than plastic; and the use of natural dyes, to ensure a non-toxic finish. A municipality in the state of São Paulo, Brazil, located in the Baixada Santista Metropolitan Region, in the micro-region of Santos, "Bertioga" takes its name from the Tupi word "buriquioca", which means "house of the big monkeys," referring to the muriqui, a primate native to the region. The area has been occupied by Tupi tribes since prehistoric times, with archaeological evidence found in the sambaquis. The city itself originated in 1532 with the construction of Fort São Tiago, which was intended to defend against attacks by the Tupinambás and the French. In 1552, Hans Staden, a German artilleryman, was captured by the indigenous people and released after French intervention, becoming famous for his accounts of the Tupinambás. The local economy prospered for centuries thanks to whale oil, but declined in the 19th century, resulting in the isolation of the region for about 100 years. Tourism boosted its development between 1930 and 1940, especially after the creation of SESC in 1948. Bertioga became a municipality in 1991 and joined the Baixada Santista Metropolitan Region in 1996. Rapid population growth since the 2000s, associated with the urbanization of Riviera de São Lourenço, has intensified social inequalities, with real estate speculation pushing low-income populations to remote areas and environmental preservation areas, creating urban and social challenges.

The term caiçara refers to the coastal communities of São Paulo, descendants of the miscegenation between indigenous peoples, Portuguese, and Africans. Its etymological origin comes from the Tupi language, meaning "surrounded by branches and sticks," used to protect villages. Historically, these communities survived on fishing, subsistence agriculture, and gathering, maintaining a close relationship with nature. Their artisanal production uses natural materials such as wood, plant fibers, and ceramics. However, due to environmental laws and greater ecological awareness, materials such as shells have been set aside to avoid impacts on the ecosystem.

The history of utensils in Brazil reflects the cultural diversity formed by the miscegenation between indigenous peoples, Portuguese colonizers, and enslaved Africans. The colonists used a variety of utensils,

Figure 9 – A, B: Bertioga artisanal fair



Source: <https://www.bertioga.sp.gov.br>. Access: 09/04/2025.

from fine china to ceramics and wood. The enslaved, on the other hand, mainly used simple ceramics without refined finishes, influencing the aesthetics of caiçara utensils.

Figure 10 – A, B, C, D: Indigenous utensils

Source: <https://tucumbrasil.com/collections/utensilios>. Access: 09/04/2024.

Archaeological studies show that ceramics had different functions, such as consumption, storage, and cooking, with a strong indigenous influence. Indigenous utensils were rudimentary and took advantage of natural forms, such as coconut shells for bowls and wood with thorns for grating manioc. In addition to functionality, the decoration of utensils had symbolic and ritualistic importance. Noteworthy is the production

in São Sebastião, where Camila Agostini studies the influence of African culture on the aesthetics of caiçara culture utensils:

> "This 'commonplace' of a dominant Africanized aesthetic in public spaces, particularly in service areas, may have fostered a general context in which it was socially acceptable for kitchen utensils, for example, to also bear the exotic insignia of an aesthetic that, although subordinate, dominated the city. [...]" (Agostini, Camila 2013, p. 11-12.)

The Caiçara culture preserves this heritage, balancing tradition and modernity. Utensils such as iron pots and wooden spoons remain essential in traditional cuisine. In addition, natural materials and animal parts are reused, such as mollusk shells and crab shells, demonstrating the creativity and adaptation of caiçara practices over time.

The choice of the spoonbill *(Platalea ajaja)* as inspiration for the project came from research on the identity of Bertioga, where the bird was one of the candidates for the city's symbol. Its spoon-shaped beak naturally aligned with the theme of utensils. The name derives from the Latin platalea and the Tupi ayaya, meaning "pink bird with a spoon-shaped beak." Belonging to the Threskiornithidae family, the spoonbill inhabits aquatic environments in South America, Central America, and the southern United States. It measures between 68.5 and 86.5 cm and weighs between 1150 and 1400 g, with no obvious sexual dimorphism. Its wings allow passive gliding and its lobed feet facilitate locomotion in the water. Its diet includes small fish, amphibians, insects, and crustaceans, obtaining its pink color from the carotenoids present in its food. It lives in flocks, nests in mixed colonies, and reaches maturity at three years of age. It has a life expectancy of between 10 and 15 years.

Figure 11 – Roseate Spoonbill

Source: <https://pt.wikipedia.org/wiki/Platalea_ajaja>. Access: 10/05/2024.

Another important topic that involves utensils is microplastics, plastic fragments smaller than 5 mm, that have become a growing threat to both the environment and human health. Research indicates that plastic kitchen utensils, especially when heated, can release microparticles that contaminate food and may be ingested, posing potential toxic and hormonal risks (Jambeck *et al.*, 2015; Bouwmeester; Hollman; Peters, 2015; Wright; Kelly,

2017). Beyond health concerns, the improper disposal of these items contributes to ocean and marine ecosystem pollution (Cózar *et al.*, 2014). Scholars advocate for replacing them with biodegradable, compostable, or natural materials such as glass, wood, and stainless steel (Rochman *et al.*, 2013).

Although wood is often seen as less hygienic due to its porous nature, studies (Aviat *et al.*, 2016) report no cases of foodborne outbreaks linked to its use. It remains essential in traditional sectors such as winemaking, cheese production, and food transport. Moreover, natural compounds found in wood — including phenols, tannins, and flavonoids — exhibit antimicrobial activity against bacteria, yeasts, and some fungi. A review of 86 studies concluded that wood is suitable for direct contact with food, particularly in single-use packaging, and its ecological and renewable characteristics strengthen its value as a sustainable alternative for the food industry.

The project also included experiments with natural dyes, conducted during a workshop led by Felipe Gustavo de Melo. In this session, several natural pigments were produced, resulting in colors such as black, brown, green, yellow, and red. Since these are natural dyes, some mixtures did not strictly follow the relationships of the color wheel. For example, pomegranate, which typically yields a yellowish tone, when combined with the ebonizing solution made from vinegar and steel wool, produced a black pigment.

The following color mixtures were obtained: a) Yellow: Pomegranate + Alcohol / Turmeric + Alcohol; b) Orange: Saffron + Poinsettia + Alcohol; c) Red: Poinsettia + Alcohol; d) Dark Red: Poinsettia + Alcohol + Ebonizer*; e) Green: Spirulina + Alcohol; f) Brown: Coffee + Water; *The ebonizer is a traditional mixture used to darken wood, made from vinegar and steel wool.

During the workshop, color tests were carried out on pieces of Tipuana wood, chosen for its naturally light tone. The samples were sanded and divided into sections for the application of different dyes. Although the results were satisfactory, it was observed that natural dyes tend to fade or change color over time. In the case of kitchen utensils, which are exposed to temperature variations, usability tests will be necessary to verify color stability. However, the experiment showed that it was possible to reproduce the color palette of the roseate spoonbill, being pink, yellow, and black, with white represented by the natural color of the wood.

After the workshop, further experiments were conducted to obtain redder tones using food-based ingredients to minimize dye toxicity. Tests were performed with mulberries (harvested on campus), beetroot, and annatto seeds. The process involved grinding the ingredient, placing it in a pan, adding 90% alcohol and/or isopropyl alcohol, and boiling the mixture for about ten minutes until the pigment was released. The liquid was then filtered through paper filters. The results showed that annatto produced an orange tone, mulberry resulted in a pinkish tone, and beetroot in a deeper pinkish-red tone. The latter was used on the final pieces, as it most closely resembled the colors of the roseate spoonbill.

3.2 Design requirements, validation, sketches and prototyping

The research activities began with the collection and selection of pruning wood from the University of São Paulo campus (CUASO), followed by preliminary characterization of the material regarding density,

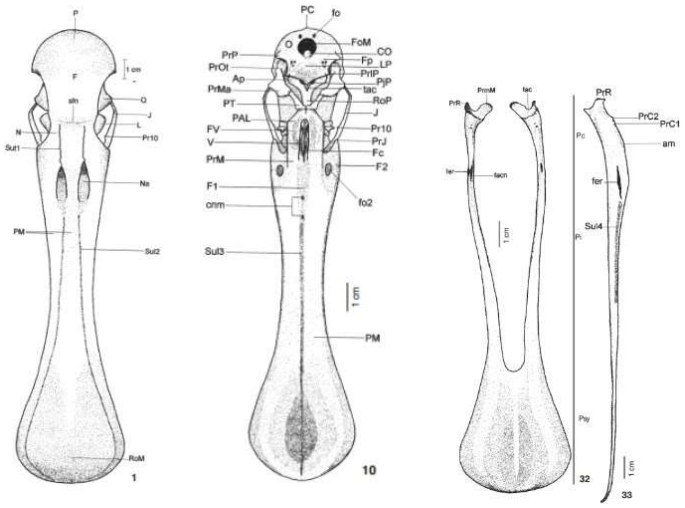
sanitary conditions, presence of defects, and suitability for food-related use. In parallel, an osteological analysis of the *Platalea ajaja* was conducted, examining measurements, proportions, and morphological characteristics of the skull, beak, and mandible to extract parameters adaptable to utilitarian objects. This process included photographic documentation, technical drawings, and digital modeling. Additionally, experiments with natural pigments were carried out to assess their applicability and stability in domestic-use utensils.

In order to develop the tools, it was first necessary to establish the design requirements, followed by a formal analysis of the bird, followed by the preparation of drafts and the completion of prototyping.

The requirements for the development of the utensils in this article were divided into: Mandatory: a) Be made from pruned wood and urban waste wood; b) Be produced using traditional carpentry techniques; c) Be based on the shape of the head of the spoonbill *(Platalea ajaja)*. And desirable: a) Use natural dyes and finishes; b) Use pink-colored wood.

The study of the shape of the utensils to be produced began with an osteological analysis of the spoonbill, its skull, beak, and jaw, and how these bones could be adapted for utensils made of wood, respectively, a shell, spoon, and tongs.

Figure 12 – Skull and jaw *(Platalea ajaja)*

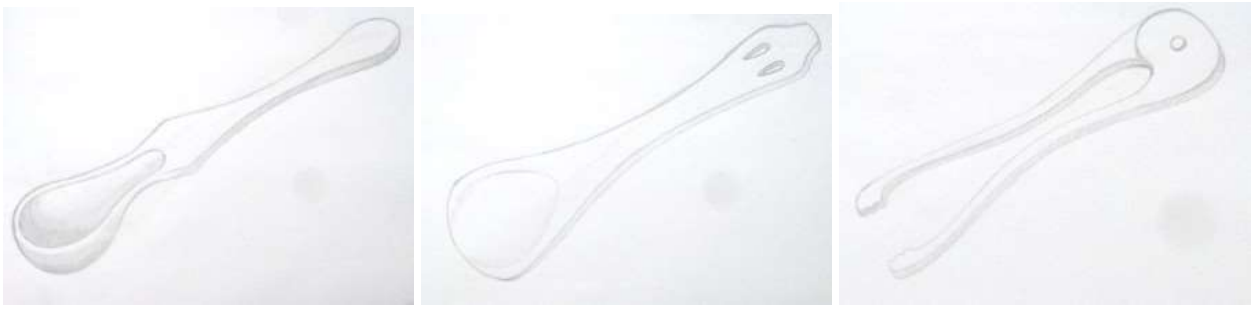


Source: FERREIRA, Carolina D.; DONATELLI, Reginaldo J. Osteologia craniana de Platalea ajaja (Linnaeus) (Aves, Ciconiiformes), comparada com outras espécies de Threskiornithidae. Revista Brasileira de Zoologia, v. 22, p. 529-551, 2005.

The 3D model of the skull was printed in real size on a Sethi 3D S3 machine with a printing area of 270x270x320mm, taking about two hours to print. After that, the supports were removed and the piece was sanded, but as there were still many flaws, the piece received a layer of epoxy putty (caulking compound) - Durepoxi, in order to achieve a better finish. After being sanded, it was finished with a layer of gray water-based primer paint - Corfix, thus allowing for better observation of the details and the piece as a whole.The designs developed in the first stage sought to improve some ergonomic aspects related to the handle and also the characteristic functionality of the utensils. The angle and area of the scoop were increased to capture more food, and the width of the handle was reduced and curved for a better grip. The thickness of the spoon was

increased so that the concave part would be more prominent. As for the tongs, although the adapted model was not made in wood, it was observed in the wooden jaw piece produced that the flexibility was not very great, and that the piece would probably have to be divided into two parts. Thus, the design of the piece includes a spring so that the utensil has some flexibility.

Figure 13 – A, B, C: Sketches



Source: Authors.

The experimental design was structured to integrate both digital and analog methods. Wood preparation included manual cutting, progressive shaping, and surface finishing using sandpaper of various grits. The adaptation of forms derived from the spoonbill's anatomy was guided by parameters obtained through the drawings, 3D scanned model and the printed skull, enabling direct study of proportions and volumetrics. The choice of species used in the prototypes considered factors such as density, carving feasibility, mechanical resistance, and sanitary suitability for contact with food. The production of the utensils continued from the initial prototyping, developing more shapes for the spoon, ladle, and tongs based respectively on the bird's beak, skull, and jaw. In addition, small objects such as knives and spoons were also developed. Production followed a traditional manufacturing method, avoiding the use of advanced machinery (CNC and laser cutting). The initial cutting of the pieces was done using a hacksaw and jigsaw, and once the solid shape of the object was achieved, it was rough-sanded following the markings. After that, the final shape was obtained using a chisel and micro grinder to carve the concavities of the pieces. The surface finish was done using different grades of sandpaper, ranging from 60 to correct the shape, to 220 to make the piece smooth. Natural dyes made from beetroot and blackberry based on isopropyl alcohol were also used to achieve a color similar to that of the bird. The treatment of the pieces varied, with some receiving only mineral oil, while others received mineral oil, vegetable dye, and/or beeswax.

4 ANALYSIS OF RESULTS

The results demonstrate a clear relationship between the methodological stages and the prototypes developed. Each final utensil was selected based on the fulfillment of the design requirements established during the Define phase, such as ergonomics, morphological fidelity, and feasibility of artisanal production. The Develop phase was essential for understanding the specific limitations of each wood species, with some species

Figure 14 – A, B, C, D: Prototype production

Source: Authors.

Figure 15 – A, B: Study of the use and cutting of parts

Source: Authors.

Figure 16 – A, B: Application of natural dyes and mineral oil

Source: Authors.

available not being used due to the low hardness necessary for utensils, enabling successive adjustments to thickness, curvature, and concavity. The process confirmed the initial hypothesis that bioinspired forms can be

Figure 17 – A, B, C: Initial prototypes and printed skulls and final prototypes of the small spoons and knives

Source: Authors.

Figure 18 – A, B, C: Final prototypes of the spoon, tong and ladle

Source: Authors.

translated into functional objects using urban pruning wood, provided that strict criteria for material selection and technical adaptation are applied.

The project aimed to produce utensils from pruned wood based on the shapes of the spoonbill bird. In this regard, the project was successful, developing a series of prototypes that follow the design concepts outlined at the outset, namely: a) Circular economy and sustainable design, working with a renewable material that can be incorporated into circular production; b) Regenerative culture design, incorporating systems based on natural forms to promote sustainability; waste minimization systems; social equity and resilience systems by proposing the participation of local artisans; and valuing cultural and biological diversity. Thus, in the long term, aiming at environmental regeneration; c) Slow Design, by holistically analyzing the production process, from the obtaining of raw materials (pruned wood) to the manufacture of objects (artisans), which incorporates a C2C (Cradle to Cradle) system, with limited and controlled production that seeks to avoid waste production; d) Biomorphism, since the design of the objects is based on the original shape of the bird's skull (Colhereiro) to develop utensils that highlight the local culture and fauna. e) Design and territory, by including not only a local material (urban pruning wood), but also the work of artisans and symbols of local culture (Colhereiro);

f) Urban pruning wood, by researching and identifying local tree species and developing a project that can use them as efficiently as possible, proposing products that can be manufactured even with small pieces and/or scraps of wood.

Most of the objects produced used tipuana wood *(Tipuana tipu)*, a yellow colored wood which has a medium density, making it easier to carve and shape the desired form of the utensils, especially the spoons. The knives on the other hand needed a higher density wood since the form is thinner, making it fragile. Thus, the available wood selected to be used were the eucalyptus *(Eucalyptus grandis)* and marsh eucalyptus *(Eucalyptus robusta)*, a high density wood with a rose-orange core and dark brown alburnum, which was also used for burnishing all the prototypes in order to make them more resistant.

5 CONCLUSION

The research presented limitations related to the heterogeneity of the available wood, often compromised by fungi, termites, or fissures resulting from the conditions of tree fall and storage. This required increased selectivity and adaptive strategies during production. Additionally, the durability of natural pigments remains an open question, especially considering the conditions of everyday use in kitchen utensils. Future stages of the research include conducting systematic tests with artisans from Bertioga, evaluating the utensils' resistance under real-use conditions, and exploring new natural surface treatment methods that balance food safety with greater chromatic stability.

Overall, the results obtained were satisfactory. The work is intended to be continued, and it is hoped that artisans from Bertioga will be able to participate in order to help preserve, enhance, and develop the artisan culture in the city. The project also contributes to SDG 11-Sustainable cities and communities by including the work of local artisans in the production of utensils from pruned wood, in order to help develop a circular economy that is sustainable and helps to protect cultural and natural heritage, while preventing urban tree waste from being sent to dumps and landfills. Another important factor was the choice to use a natural finish on the utensils, with mineral oil and beeswax, which, although non-toxic, require more maintenance and must be reapplied after use and washing. The same is true for the application of natural dyes, which tend to lose their color over time.

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