Jéssica Ester Elvas Costa, Claudete Catanhede do Nascimento, Jorge Alves de Freitas*

# Macroscopic anatomical characteristics of amazon forest species in the development of visual patterns in Surface Design

**Abstract** The Amazon rainforest presents a diversity of species that can be explored and disseminated through Surface Design in conjunction with the area of wood anatomy. Therefore, this study aimed to generate visual patterns from the use of macroscopic images generated through the analysis of tangential, radial and transversal sections of an Amazonian species. Thus, samples of Amazonian species were collected at the Instituto Nacional de Pesquisas da Amazônia (INPA), which were scientifically identified and one of them was selected to obtain macroscopic images of the wood and visual analysis of the anatomical elements and development of visual patterns. the species Pithecellobium racemosum (Angelim Rajado) was selected. Through the results obtained, it was concluded that scientific knowledge about the anatomy of wood can be used as a creative source in Surface Design in order to disseminate and value the Amazonian Forest diversity.

**Keywords** Wood anatomy, Amazonian timber, Surface design.

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## Características anatómicas macroscópicas de especies forestales amazónicas en el desarrollo de patrones visuales en Diseño de Superficies

**Resumen** *La selva amazónica presenta una diversidad de especies que pueden ser exploradas y difundidas a través del Diseño de Superficies en conjunto con el área de anatomía de la madera. Por lo tanto, este estudio tuvo como objetivo generar patrones visuales a partir del uso de imágenes macroscópicas generadas mediante el análisis de secciones tangenciales, radiales y transversales de una especie amazónica. Así, se recolectaron muestras de especies amazónicas en el Instituto Nacional de Pesquisas da Amazônia (INPA), las cuales fueron identificadas científicamente y una de ellas fue seleccionada para obtener imágenes macroscópicas de la madera y análisis visual de los elementos anatómicos y desarrollo de patrones visuales. se seleccionó la especie Pithecellobium racemosum (Angelim Rajado). A través de los resultados obtenidos se concluyó que el conocimiento científico sobre la anatomía de la madera puede ser utilizado como fuente creativa en el Diseño de Superficies para promover y valorar la diversidad de los bosques amazónicos.*

**Palabras clave** *Anatomía de la madera, Madera amazónica, Diseño de superficie.*

## Características anatômicas macroscópicas de espécie florestal da Amazônia no desenvolvimento de padrões visuais em Design de Superfície

**Resumo** *A floresta amazônica apresenta uma diversidade de espécies que podem ser exploradas e divulgadas por meio do Design de superfície em conjunto com a área da anatomia da madeira. Logo, este estudo teve como objetivo a geração de padrões visuais a partir da utilização de imagens macroscópicas geradas por meio da análise dos cortes tangencial, radial e transversal de uma espécie amazônica. Assim, foram coletadas amostras de espécies amazônicas no Instituto Nacional de Pesquisas da Amazônia (INPA), sendo estas identificadas cientificamente e feita a seleção de uma destas para obtenção de imagens macroscópicas do lenho e análise visual dos elementos anatômicos e desenvolvimento dos padrões visuais, sendo selecionada a espécie Pithecellobium racemosum (Angelim Rajado). Por meio dos resultados obtidos concluiu-se que o conhecimento científico acerca da anatomia das madeiras pode ser utilizado como fonte criativa no Design superfície a fim de divulgar e valorizar a diversidade florestal amazônica.*

**Palavras-chave** *Anatomia da madeira; Madeira amazônica; Design de superfície.*

## Introduction

The Amazon Forest is rich in forest species and their identification is made through anatomy, branch of botanical science that studies the internal structure of wood, its cellular composition and functions of each element that constitutes it (BOTOSSO, 2011).

Wood, being a heterogeneous organism, it is comprised of cells arranged and organized in different orientations, and this characteristic gives it a difference in its appearance according to the observation planes, namely the transverse, longitudinal radial and longitudinal tangential (BURGER; RICHTER, 1991). According to Freitas and Vasconcellos (2010), through the aid of these observation plans it is possible to study the anatomical structure of the wood and, for this, analysis techniques such as macroscopic are used.

Macroscopic features can be grouped into two distinct groups: organoleptic and anatomical. According to Freitas and Vasconcellos (2010) the organoleptic characteristics include the color, brightness, odor, taste, grain, texture and figure of the wood. Anatomical characteristics, on the other hand, bring together aspects related to the shape, size or distribution of cellular elements, the main ones being: axial parenchyma, vessels (pores), rays, besides vascular lines, medullary macules, axial and radial secretory channels (FREITAS; VASCONCELLOS, 2010). These elements have unique shapes and visual characteristics.

According to Pacheco et al. (2008) there are numerous scientific papers on the variety of tree species, their technological behavior and anatomical data, however, despite the vast scientific production in this context of knowledge of the characteristics of wood, such information, mainly the anatomical ones, can also be explored visually as inspiration for creating visual patterns.

The development of these visual patterns is the focus of projects developed in Surface Design. For Gajardo (2017), Surface Design has as its special feature the wide possibility of being implemented in collaborative projects with different areas of activity, thus developing generally interdisciplinary projects "with the intention of innovating, producing and improving everything that involves interference on surfaces".

Thus, the motivation of this research derives from the opportunity and importance of promoting and valuing wood in a different way through interdisciplinarity between different areas of knowledge, such as Surface Design and Wood Anatomy, as well as studying wood through graphic art.

Thus, the aim is to show that the anatomical macroscopic elements of wood can be used creatively in Surface Design projects by exploring the naturally generated visual compositions in wood through the shape, size and distribution of the cell elements.

In this context, this research had as general objective the generation of visual patterns from the use of macroscopic images generated through the analysis of the observation plans of the wood of an Amazonian tree species.

## Theoretical Reference

### Surface Design fundamentals

Surface Design is a field of action within Design which, according to Rüthschilling (2008), has as its general objective the creation of visual or tactile textures from two and three-dimensional images to compose the surfaces of objects or structures, presenting solutions aesthetic, symbolic and functional, thus exercising a technical and creative design activity for the construction of visual patterns.

For a visual pattern, it is necessary to understand the basic constructive elements, which are considered as technical foundations for the creation of patterns (LIMA, 2013). Thus, the following basic fundamentals will be highlighted here: Elements with the following fundamentals; Module; Multimodule; Fitting; Repetition systems; and grid.

The visual pattern is formed by the set of units that together visually characterize it. Rüthschilling (2008) defines these units as a module, which is the smallest area that includes all the visual elements used in the pattern, which are defined as compositional elements, which are: figures or motifs, filling elements and elements of rhythm.

- **Figures or motifs**
  The figures or motifs are the visual elements that define the theme of the composition according to the selected elements (RÜTHSCHILLING, 2008).
- **Filling elements**
  The fill elements are located on the background of the print (FEITOSA, 2019), which can be textures, graphics, or a color chosen to fill the plane or layer, also assuming the role of visually connecting the other elements (RÜTHSCHILLING, 2008).
- **Elements of rhythm**
  Rhythm elements are the ones that stand out the most for their visual force generated by the contrast derived from colors, position or dimensions of the elements, guiding the reading of the pattern due to the sensation of movement it promotes (RÜTHSCHILLING, 2008). They are responsible for visual propagation (MARCOS E SCHULTE, 2018) and how we perceive the entirety of the print (FEITOSA, 2019). It is noteworthy that the existence of the rhythm element depends on the relationship with one of the previous elements, not existing without such interaction (RÜTHSCHILLING, 2008).

It is noteworthy that the behavior of the compositional elements in the pattern is defined according to the visual influence that color, position or dimension will exert on the given element (RÜTHSCHILLING, 2008), with no permanent categorization since "the relationships assumed by them will always be determined by the visual choices made in the construction of the pattern" (SANTOS, 2020). In addition, the joint use of the three elements is not mandatory (FEITOSA, 2019).

Knowing that the compositional elements of the visual pattern are contained within the module, it is necessary to understand how to work them within it, especially in patterns or running prints, where the notion of fitting is important.

According to Rüthschilling (2008), the fit is the study of the meeting points of the motifs and other compositional elements between one module and another so that it forms the projected design without interruptions or mismatches when such module is replicated. Also, according to the author, the principles of continuity and contiguity support the notion of fit, since in Surface Design the concept of continuity refers to the effect of orderly and uninterrupted propagation of visual elements in the pattern, and contiguity refers to the harmony of the elements. visual elements in the proximity of the juxtaposed modules, corroborating the perception of continuity of the pattern. With this the module in rapport is formed.

Cavalcanti and Rocha (2016) emphasize that the fittings of the module must be carefully thought out "because articulating the encounters of its ends can result in a more fluid repetition". Rosa (2017) emphasizes that it is from carrying out the fitting study that the module becomes replicable for the effective composition of the print.

To carry out the study of fittings, Schwartz (2008) proposes the visualization of the effect and composition of the visual elements contained in the module through the so-called Composition Unit, referring to the grouping of this module in a minimum set of 4 units of itself. Also, according to the author, from the Compositional Unit, it is possible to establish a multi-module.

> "It can be said that the Multimodule constitutes a modular unit of repetition, as it is this set of elements that will be replicated as a formal unit, which may be equivalent to the Compositional Unit or a larger set of elements. [...] Ultimately, it can be said that the System will be equivalent to the repetition of the multi-modules in the possible directions, depending on the format of the Basic Module." (SCHWARTZ, p.64-65, 2008)

It is understood then that in the multimodule a smaller system (compositional unit) will adopt the function of a single module, giving rise to other systems, and its use can give rise to new combinatorial possibilities for the creation of the visual pattern.

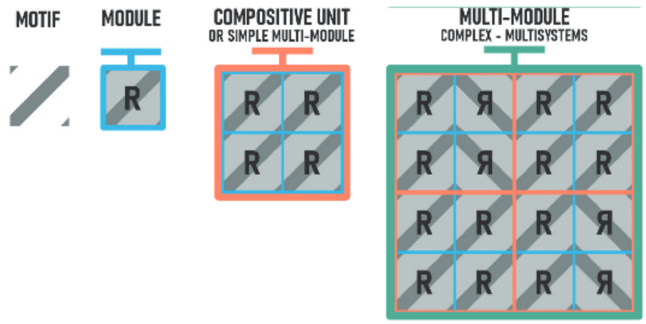


**Figure 1:** Structural composition of the module, compositional unit and multi-module.
**Source:** authors (2022), based on Schwartz (2008) and Rüthschilling (2008)

The dispositions that the modules assume in different orientations are given by the Repetition Systems. Thus, after defining the final module, formal unit or multi-module, the propagation of the design that forms the visual pattern or running print takes place through repetition (rapport, in French) that can be logically organized through repetition systems, as highlighted by Rüthschilling:

> "The notion of repetition in the context of surface design is the placement of modules in both directions, length and width, in a continuous way, configuring the pattern. [...] the logic adopted for the repetition is called "system", that is, the way in which a module will be repeated at constant intervals." (RÜTHSCHILLING, p.67, 2008)

Schwartz (2008) also highlights that "ultimately, it can be said that the System will be equivalent to the repetition of multi-modules in possible directions".

Among the repetition systems, the aligned and non-aligned systems that define some possibilities for the arrangement of the modules stand out here.

- **Aligned system**
  Maintains the alignment of the modules by repeating them without origin offset, but presents the possibility of changing the axis and orientation of the module when repeating it (RÜTHSCHILLING, 2008). Therefore, the modules are fitted into the grid following a single horizontal and vertical alignment pattern (ROSA, 2017). Among the possible variations of aligned systems, translation, rotation, reflection and inversion stand out (RÜTHSCHILLING, 2008; SCHWARTZ, 2008).

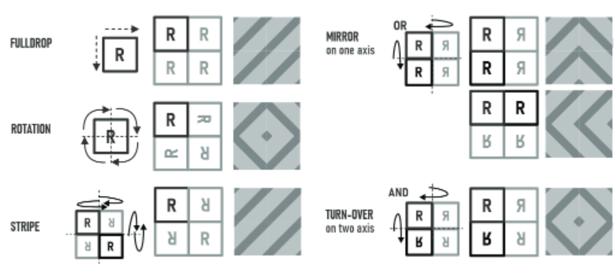


**Figure 2:** Models of Aligned Repetition Systems.
**Source:** authors (2022), based on Schwartz (2008).

- **Non-Aligned System**
  Does not maintain module alignment, allowing change of origin point, displacing the module in a vertical or horizontal direction. (RÜTHSCHILLING, 2008). This system also allows the possibility of variation in translation, rotation and reflection, and the vertical displacement is called Half-drop and the horizontal is called Brick, resulting from the displacement until half of the module (SCHWARTZ, 2008).

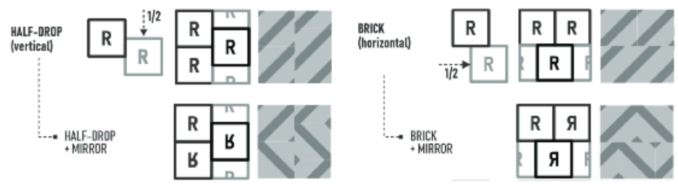


**Figure 3:** Models of non-aligned repeating systems.
**Source:** authors (2022), based on Schwartz (2008).

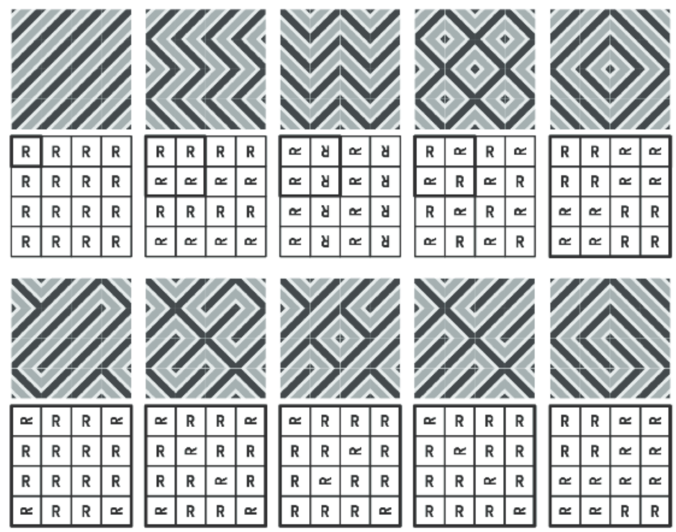

**Figure 4:** module, compositional units and multi-modules.
**Source:** adapted from Rüthschilling (2008).

It can then be seen that the type of repetition system generates a "mesh" or grid that displays the composition and arrangement of the modules, that is, "the format of the Module conditions the format of the Mesh, or other way around" (SCHWARTZ, 2008). Thus, Proctor (1990, p.9) defines grid as "a regular network or pattern of (usually straight) lines used to correctly place a pattern on a surface".

From this information on the basic foundations of Surface Design, it is possible to outline in general the elements present in the processes of developing a continuous visual pattern, as illustrated in Figure 5.

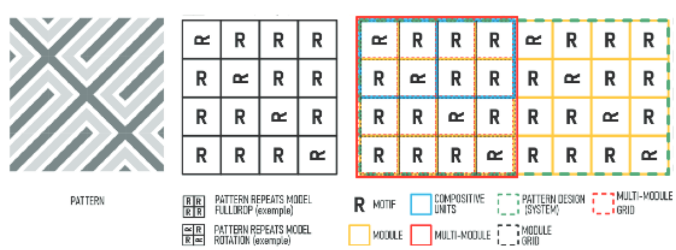


**Figure 5:** basic structural elements that compose a pattern in Surface Design projects.
**Source:** authors (2022), based on Schwartz (2008) and Rüthschilling (2008).

## Macroscopic anatomical features

The wood cells are arranged in different directions, giving it different aspects according to the face or wood section, being it transverse, radial longitudinal and tangential longitudinal (BURGUER; RICHTER, 1991). The anatomy of wood is study and observation in these sections. Botosso describes them as follows:

> "Transverse direction (X): that perpendicular to the stem axis. A cut in this plane provides a cross section of the tree axis, corresponding to the cross section (or top) of a trunk or piece of wood;
> Radial longitudinal direction (R): that oriented along the radii in cross section. Parallel to the rays or perpendicular to the limit of the growth rings, in a cut plane passing through the pith;
> Tangential longitudinal direction (T): that taken tangentially in relation to the limit of the growth rings, or perpendicular to the direction of the rays, which is parallel to the axis of the stem (trunk)." (BOTOSSO, p.16-17, 2011)

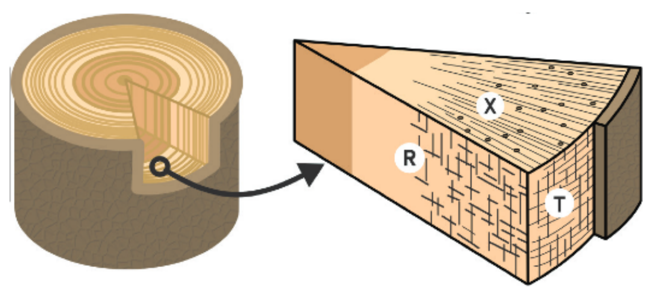


**Figure 6:** scheme of sections or wood observation plans.
**Source:** authors (2022), based on Botosso (2011) and Burger and Richter (1991).

In each of these three cutting directions it is possible to observe the macroscopic anatomical characteristics of the wood with a distinct appearance. Macroscopic anatomical features are those that can be observed with the naked eye or with the aid of magnifying lenses and such features are better observed after polishing the wood surface with a sharp blade (ZENID; CECCANTINI, 2007).

By displaying different visual aspects in terms of form and composition, they stand out for this research regarding the visual value are the vessels, axial parenchyma, and parenchyma rays (transverse parenchyma/ radial parenchyma).

The vessels have a continuous tube-like structure with a small diameter, which are responsible for the upward conduction of liquids in the tree, they are called "pores" when seen in the cross section of the wood (BURGER; RICHTER, 1991), displaying a circular to elliptical shape (BOTOSSO, 2011). As for their visibility, they can be visible to the naked eye, visible only under 10x lens or invisible even under 10x lens (FREITAS; VASCONCELLOS, 2010).

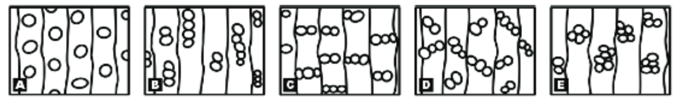

**Figure 7:** scheme of types of pore arrangement.
**Source:** adapted from Freitas and Vasconcellos (2010).

The axial parenchyma is a tissue with a storage function and is composed of cells with a normally rectangular and/or fusiform shape in the longitudinal planes, and their arrangement is observed in the cross section (BURGER; RICHTER, 1991). These can be seen in figure 8 and figure 9 where it is possible to observe their aesthetic differences.

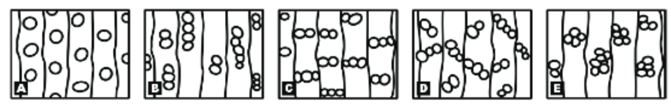

**Figure 8:** Types of apotracheal axial parenchyma.
**Source:** adapted from Freitas and Vasconcellos (2010).

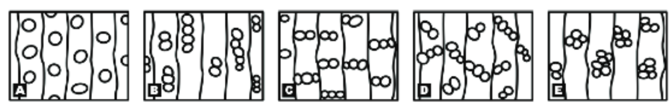

**Figure 9:** Types of paratracheal axial parenchyma.
**Source:** adapted from Freitas and Vasconcellos (2010).

On the other hand, parenchymal rays appear as elongated bundles of cells, arranged horizontally, starting from the center to the edge of the tree's circumference (ZENID; CECCANTINI, 2012), having the function of storing, transforming and conducting sap (BURGER; RICHTER, 1991).

In macroscopic identification, the rays are most commonly observed in the transversal and tangential sections (ZENID; CECCANTINI, 2012), but being also observed in the radial in the form of a band with the cells being able to assume different formats (BURGER; RICHTER, 1991). Also, according to the authors, regarding their distribution through observation in the tangential section, they are seen in one, two or more rows, respectively receiving the name of uni, bi or multiseriate. Furthermore, the rays can be stratified or not stratified according to the distribution aligned and misaligned with each other (FREITAS; VASCONCELOS, 2010).

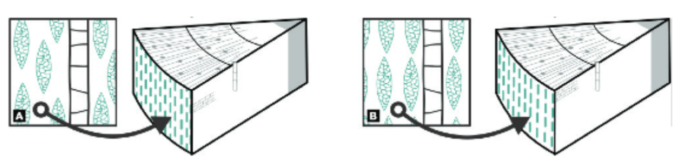

**Figure 10:** Types of arrangement of rays in the tangential plane; A-not storied, B-storied regular.
**Source:** adapted from Freitas and Vasconcellos (2010).

## Materials and methods

The research was structured in several phases that, in general, included a bibliographic survey to compose the theoretical framework; survey and selection of the study species; development of visual patterns; and digital simulation of patterns applied to apparel products.

For the process of development of patterns, we adopted the methodology proposed by Oliveira (2012) focused on the development of visual patterns with reference to natural elements, adapting the particularities of this research. In addition, the foundations and techniques of Surface Design according to Rüthschilling (2008) and Schwartz (2008) were used.

## Data survey

### – Bibliographic review

It consisted of a literature review through consultations in books, articles, dissertations and technical documents about the macroscopic anatomical structure of dicotyledonous angiosperm woods, a group in which the Amazonian woods are found. This survey aimed to provide the necessary theoretical basis for the analysis phase of the anatomical elements of the wood.

### – Collection and identification of amazon species

The selection of Amazonian species with potential for visual pattern generation was carried out at the Laboratório de Engenharia e Artefatos de Madeira (LEAM) of the Instituto Nacional de Pesquisas da Amazônia (INPA). From the species available in the laboratory, the selection was made using criteria based on the following wood organoleptic characteristics: color and figure. Seven Amazonian species were elected, which were identified by common name, scientific name and family.

For the identification of the species and subsequent observation of the basic macroscopic anatomical characteristics, a specimen duly oriented in the tangential, radial and transverse directions was prepared for each species with dimensions of 2x2x1,5 cm, respectively (Figure 11).

This procedure for species identification was carried out at the Laboratório de Identificação e Anatomia da Madeira/Xiloteca at INPA. Analysis was carried out by the laboratory specialist based on the specific techniques usually applied in the macroscopic anatomical identification of the wood, following the guidelines contained in the technical standards (COPANT, 1974; IBAMA, 1991), using mainly the macroscopic sensory and anatomical characteristics, corroborating with the careful observations made through the comparison method (Confrontation), supported by the Botanical Collection - Xiloteca / COTI / INPA. In this step, the structures were analyzed with the aid of a magnifying glass with a 10x magnification. Finally, each species was registered with its common name, scientific name and family.

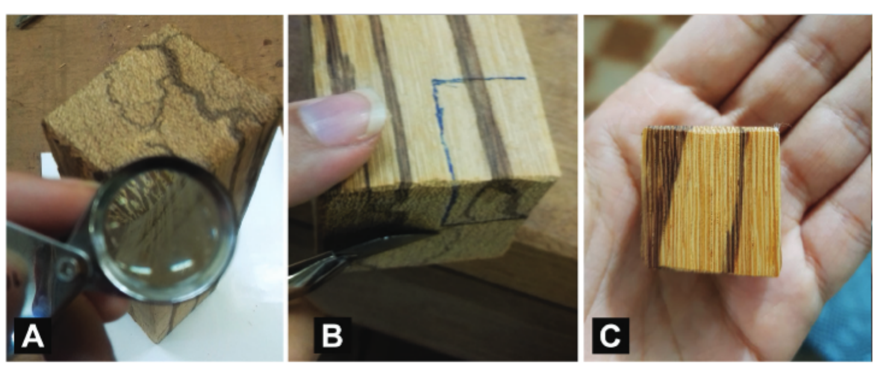


**Figure11:** Observation, orientation, marking and specimen.
**Source:** authors.

– Selection of the final species

Among the collections, the choice of the final species was made by observing the one that had a more differentiated visual aspect, using the contrast of colors and figures as a parameter.

– Photographic documentation of the chosen species

For the identification, description and photographic documentation of the macroscopic elements present on the wood surface, the surface of the specimen was moistened with water during the sliding microtome planing process, with 18 micrometers (μm), with an inclined razor at 45° (Figure 12). This procedure was performed to obtain flat surfaces and with their anatomical structure well preserved in order to obtain a better visualization of the same.

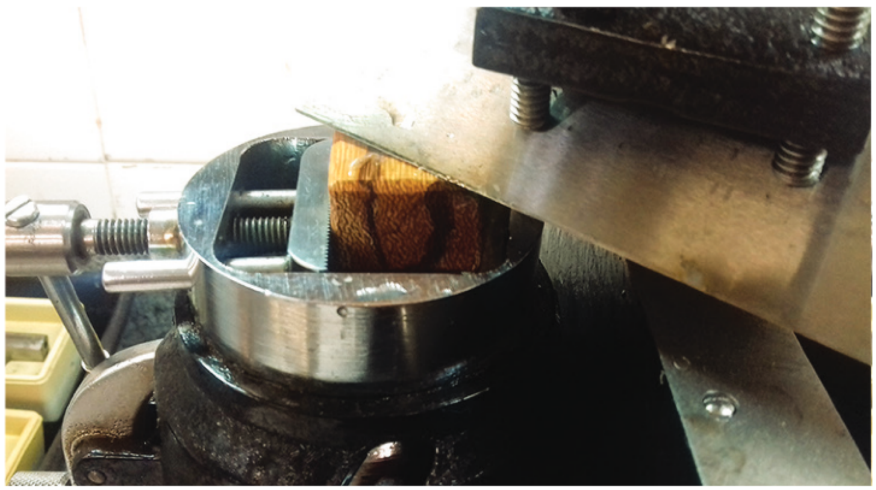

**Figure 12.** Flattening of the surfaces of the Angelim Rajado sample in the slide microtome.
**Source:** authors.

Photographic documentation was obtained by obtaining macroscopic digital images captured from the cross-sectional, tangential and radial surfaces of the specimen with the aid of a Nikon smz745t stereomicroscope with a Moticam 2300 digital microscopic camera attached. Using such equipment connected to a desktop computer, images were captured at 10, 20 and 50 times magnification using the Motic Images plus 2.0 software using the Motic Live imaging module.

From the images, the macroscopic description was made focusing on the following elements: Axial parenchyma, Pores and Rays.

These procedures were performed at the Laboratório de Identificação e Anatomia da Madeira/Xiloteca at INPA

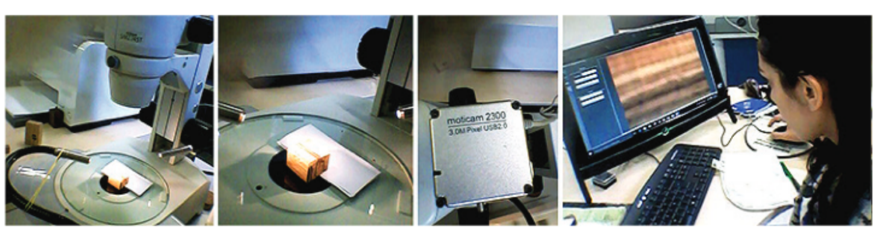

**Figure 13.** Capture of digital images of the macrographic anatomical elements of Angelim Rajado wood.
**Source:** authors.

## Construction of visual elements (motifs)

In general, the procedures used in this step consist of:

- **Choice of natural reference**
  From the photographic documentation of the three wood observation plans, the selection was made for the one that presented the greatest amount of well-defined visual elements to assist in the process of composing the motifs for the construction of visual patterns
- **Observation drawing**
  Observation and free capture of the visual element present in macroscopic digital images
- **Interpretation drawing**
  Adaptation of the anatomical elements, in view of their non-stereotyped construction, allowing to apply a style to it but without losing allusion to the reference form. Such selected elements were vectorized in a digital environment using CorelDraw software, being geometrized through the concepts of shape interrelation, but without losing the allusion to the natural shape of the elements
- **Construction of elements or motifs**
  Final construction of the visual element (motifs), being able to manipulate the element created elements of new elements, creation of support and final configurations.

## Modules composition and coloring

In this topic, the composition study of the visual elements in the modules takes place to define those that will compose the pattern in rapport. The graphic software used was CorelDraw. In addition, in this step, the color palettes and coloring of the elements that make up the module are defined, where the colors were inspired by the selected species and the other support colors were defined with the help of the color wheel. The color palette was created on the Adobe Color website.

## Rapport or repetition system configuration

In order to create the final visual patterns, a repetition study was carried out with reference to the studies of repetition systems with varieties of compositions described by Rüthschilling (2008) and Schwartz (2008).

## Digital simulation of product application

With the visual patterns or final prints, digital simulations of their application in products were carried out in order to visualize their practical application.

## Results and discussions

Among the species available at the LEAM of the INPA, 7 were pre--selected because their color and/or figure are different from the others. The scientific identification of all species was carried out and the result is presented in Table 1:

**Table 1:** Selected species and their identifications regarding the common name, common name and the family. **Source:** authors.

| IMAGE | | IDENTIFICATIONS |
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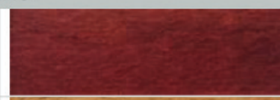
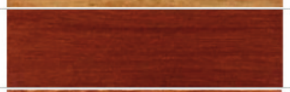
| **1** |  | Common name: Violeta<br>Scientific name: *Peltogyne catingae*<br>Family: CAESALPINIACEAE |
| **2** |  | Common name: Louro Rosa<br>Scientific name: *Aniba burchelli*<br>Family: LAURACEAE |
| **3** |  | Common name: Abiurana<br>Scientific name: *Pouteria guianensis*<br>Family: SAPOTACEAE |
| **4** |  | Common name: mandioqueira<br>Scientific name: *Qualea brevipedicellata*<br>Family: VOCHYSIACEAE |
| **5** |  | Common name: Angelim rajado<br>Scientific name: *Pithecolobium racemosum*<br>Family: MIMOSACEAE |
| **6** |  | Common name: Louro Faia<br>Scientific name: *Roupala montana*<br>Family: PROTEACEAE |
| **7** |  | Common name: Angelim Pedra<br>Scientific name: *Hymenolobium pulcherrimum*<br>Family: FABACEAE |

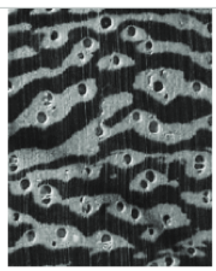
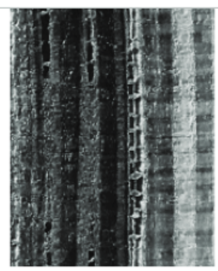
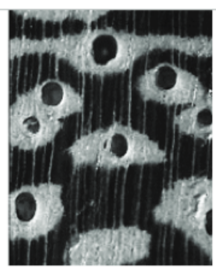
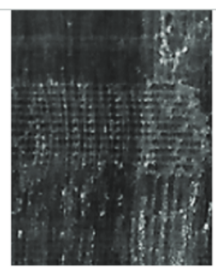
Among the listed species, *Pithecellobium racemosum* (Angelim Rajado) was selected. In the evaluation carried out with Angelim-Rajado wood, the organoleptic characteristics related to color and design were observed, where such species had a yellowish-brown tone on a brownish-yellow background, with branched forms, which is a differentiating factor among the other species Figure 14.

**Figure 14:** Image of the tangential face of the wood of the species *Pithecellobium racemosum* (Angelim Rajado) **Source:** authors.

### Macroscopic images of the selected species

The photomacrographs of the three observation planes of the Angelim Rajado species were obtained in three different sizes of image magnification, these being at 10x, 20x and 50x magnification, in which it was possible to obtain good quality images of the macroscopic anatomical elements. Among the planes, the cross section stood out in which it was possible to observe a rich visual composition arising from the shape, arrangement and contrast between the axial parenchyma, the pores and the rays. The results in image and macroscopic description are presented in Table 2:

**Table 2:** Photomacrographs in the three wood observation planes.
**Source:** authors.

| ANGELIM RAJADO (*Pithecolobium racemosum* Ducke) | | | |
|---|---|---|---|
| **Magnification** | **Transverse plane** | **Radial plane** | **Tangential plane** |
| **10x** |  |  |  |
| **20x** |  |  |  |
| **50x** |  |  |  |
| **Description** | *Axial parenchyma:* abundant paratracheal axial parenchyma, well distinct to the naked eye, predominantly confluent vasicentric, scarce simple aliform paratracheal.<br>*Pores:* visible to the naked eye and under 10x and higher magnifications, predominantly solitary, scarce tangential multiples<br>*Rays:* Poor visibility in the sample to the naked eye, but well highlighted when viewed under a magnifying glass as thin parallel lines. | | |

## Manufactured Visual Elements

To create the visual elements, the image of the cross section was selected under a 50x magnifying glass. The characteristic chosen as the main visual element (motifs) was the simple aliform paratracheal axial parenchyma. It is noteworthy that, despite this element being scarce in the sample, it stood out for presenting a simple, fusiform and somewhat symmetrical shape, in addition to having a well-marked pore in its center.

As a secondary element (motif), the rays were selected for the development of an optional fill element for the visual composition of the modules.

The result of the visual investigation for the definition of these final motifs (visual elements) is presented in figure 15 and figure 16, demonstrating the process that involves the choice of the natural reference in the image, the observation drawing through the capture of details and the drawing of interpretation of captured elements.

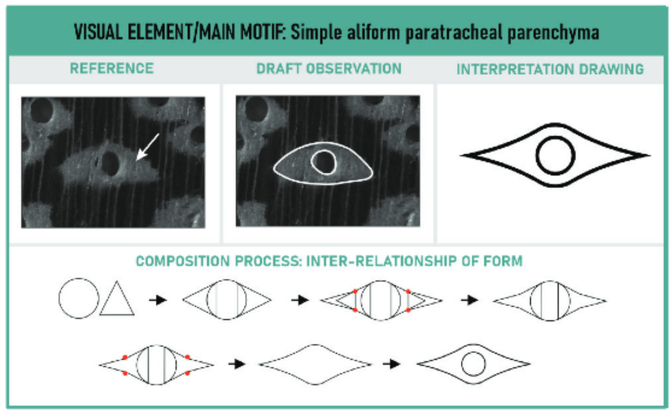



**Figure 15:** elaboration of the main motif.
**Source:** authors.

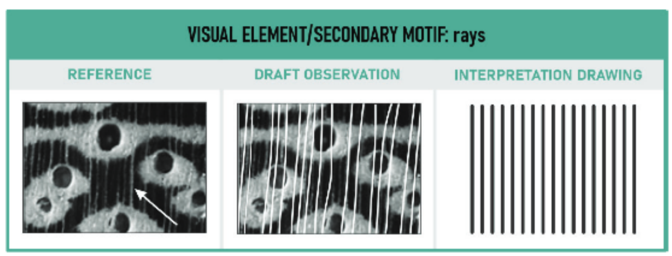



**Figure 16:** elaboration of the secondary motif.
**Source:** authors.

## Manufactured modules and color palette

The final modules were obtained by manipulating the motifs taking into account the fittings between the modules in order to establish the effect of continuity and contiguity in the visual pattern.

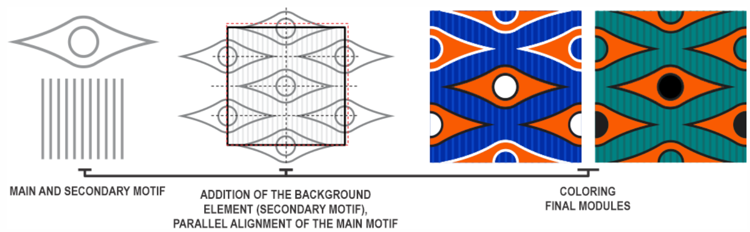
The palette was created from the harmony of Complementary colors, Monochromatic colors in shades of yellow, white and black to create additional contrast. The coloring of the modules sought to highlight the main motif, attributing a good contrast between figure and background, collaborating with the attribution of visual rhythm.


**Figure 17:** color palette.
**Source:** authors.

For the composition of modules 1 and 2, the secondary motif was used to fill the background as a texture of parallel vertical lines. The main motif was multiplied into seven units with an interleaved arrangement following the main alignments of the horizontal and vertical center of the module. It is noteworthy that the figures at the end are added in half thinking about their fittings during the repetition of the module, generating patterns in rapport with good continuity.

In addition, it is worth mentioning the influence of colors in each generated module. Despite having the same visual elements, the color modifies the perception of them, increasing or reducing the contrast according to the combination of the background color and the fill color of the motifs.

**Figure 18:** elaboration of modules 1 and 2.
**Source:** authors.




Modules 3 and 4 also share the same pattern alignment, differing only in color. The motifs have different alignments that originate from the horizontal, vertical and diagonals of the module, all passing through its center. The placement of smaller figures (motifs) with a color of greater or lesser contrast generates a different aesthetic perception in each module, dividing the focus with the larger elements, or giving them greater prominence as they are the elements of greater contrast with the background color. This demonstrates the impact colors have on the perception of visual elements.

**Figure 19:** elaboration of modules 3 and 4.
**Source:** authors.


Module 5 used only the main motif for the composition of the module, multiplying it in four units with diagonal alignment and with different dimensions, and these dimensions attribute movement to the module, guiding the reading of the pattern through the distinct visual force between the modules. motifs arising from the various dimensions that decrease from left to right towards a common point.

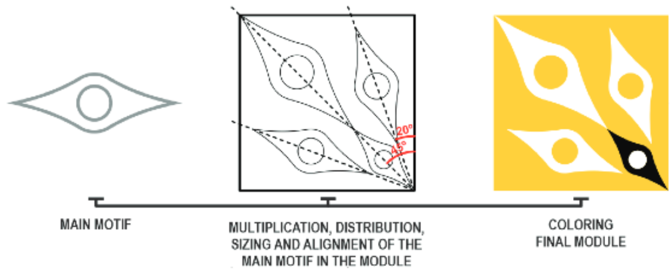



**Figure 20:** elaboration of module 5.
**Source:** authors.

Module 6 presents the main motif multiplied into eight units, all with the same visual weight as they are similar in size and color. The highlight of this module is the standardized diagonal alignment mesh, which presents the elements interspersed and in different directions. This made visually the elements that have the same direction are perceived as a group. In this way, two rhythms were generated in the visual composition of the module according to the sensation of movement promoted by the alignment of the elements to the right or left.

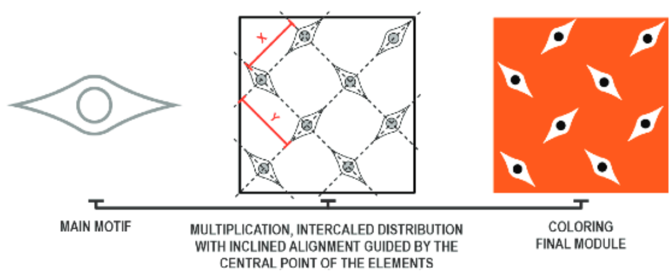



**Figure 21:** elaboration of module 6.
**Source:** authors.

## Visual standard in rapport

The visual patterns in rapport were generated from the manipulation of the modules, instituting systems of repetition that defined the visual composition of the patterns.

Making the repetition study of the modules through Composite Units and Multi-modules, those that presented the composition considered of greater visual interest were selected, as they present good contiguity and continuity in view of the fittings, resulting in a good visual propagation of the continuous pattern.

In the figures 22, 23, 24, 25, 26 and 27 the generated patterns and their respective repetition systems are presented.

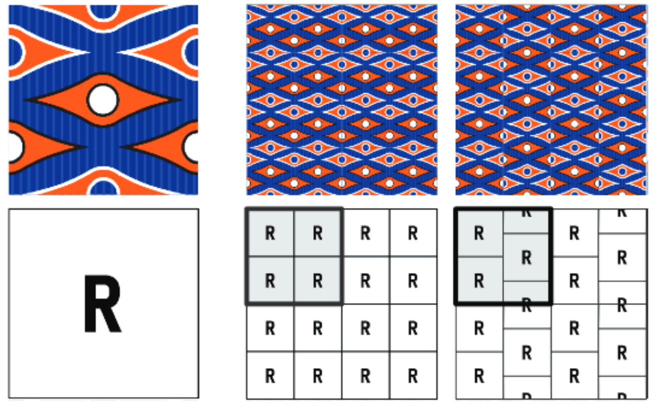


**Figure 22:** Module 1 and repetition systems defined from the compositional unit.
**Source:** authors.

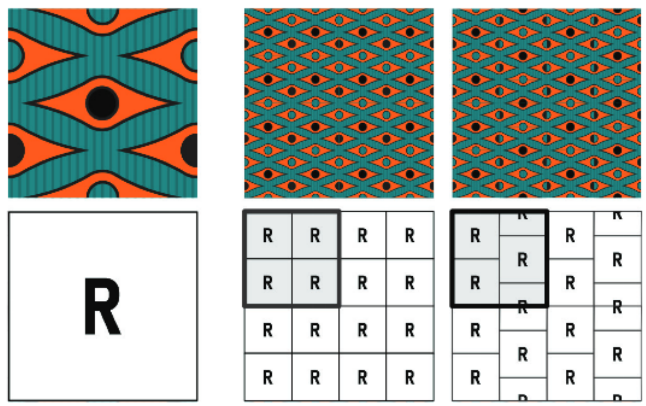


**Figure 23:** Module 2 and repetition systems defined from the compositional unit.
**Source:** authors.

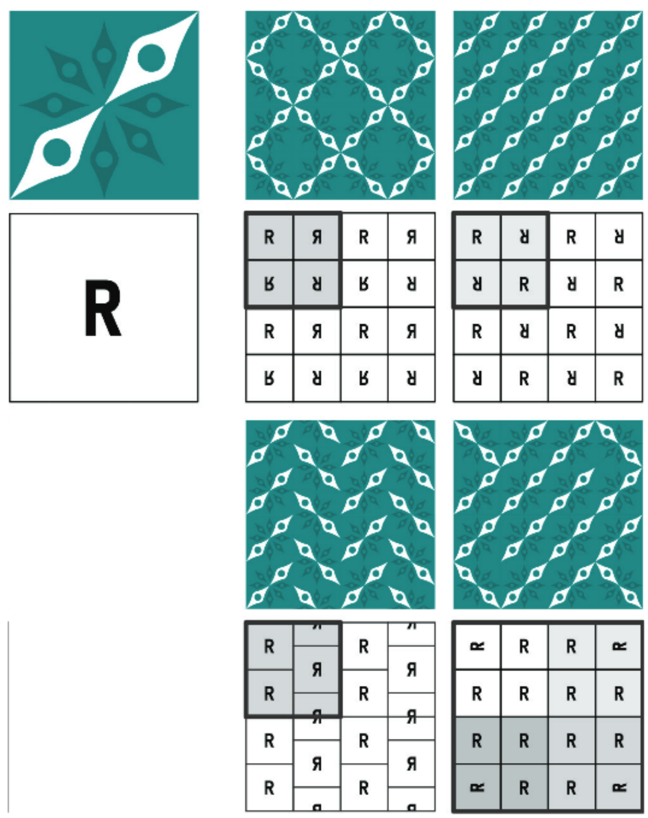


**Figure 24:** Module 3 and repetition systems defined from the compositional unit and multi-module
**Source:** authors.

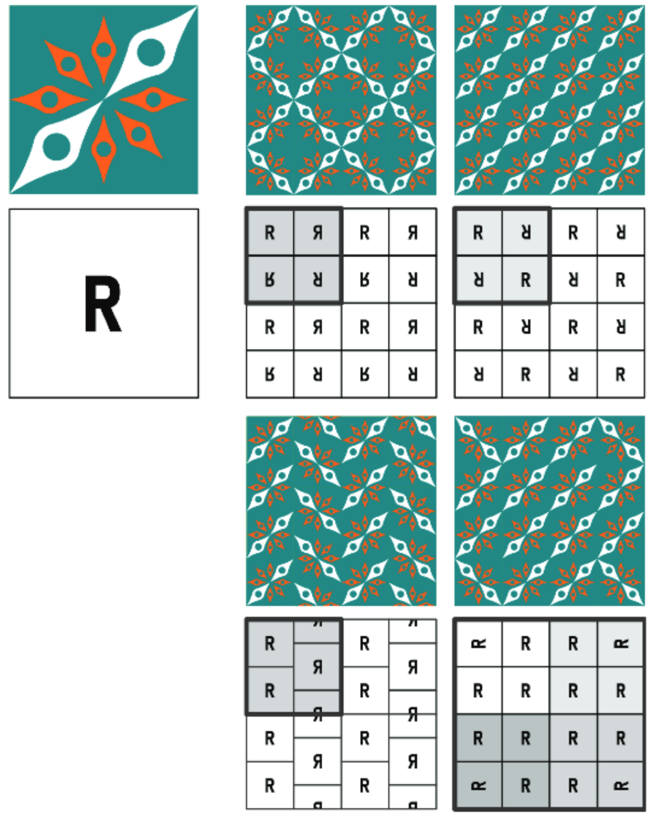


**Figure 25:** Module 4 and repetition systems defined from the compositional unit and multi-module.
**Source:** authors.

**Figure 26:** Module 5 and repetition systems defined from the compositional unit and multi-module.
**Source:** authors.

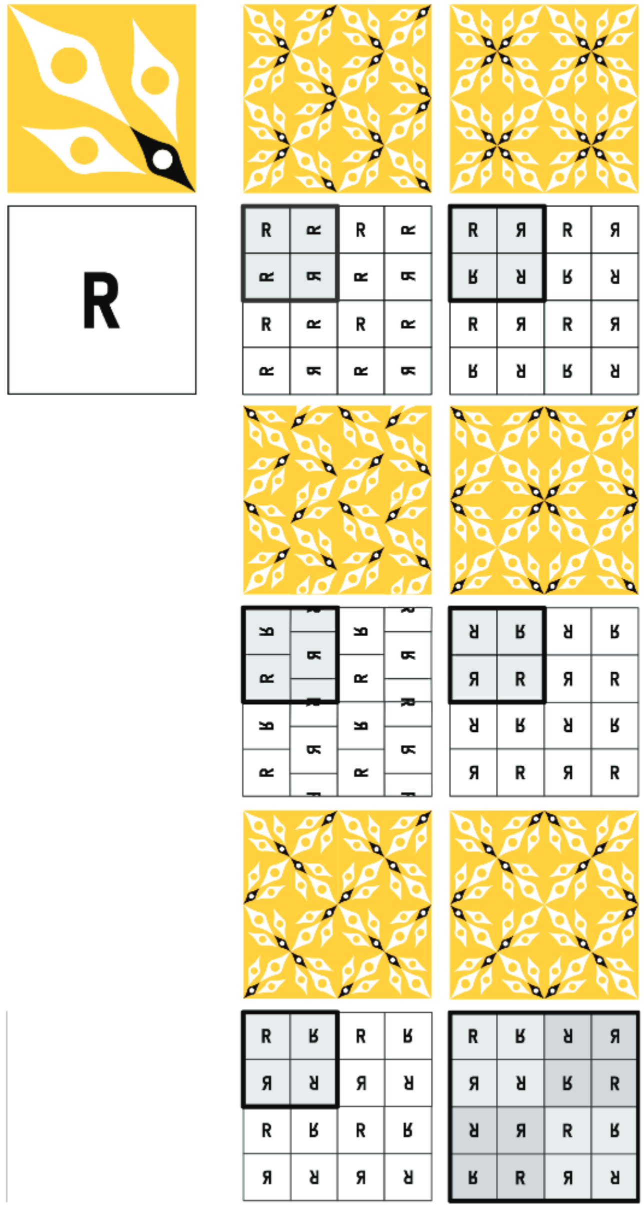
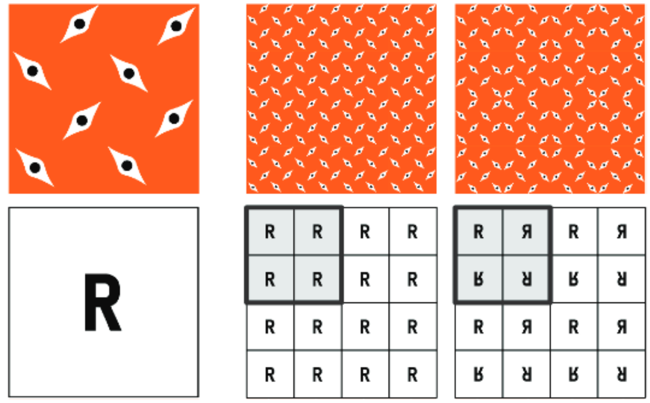


**Figure 27:** Module 6 and repetition systems defined from the compositional unit and multi-module.
**Source:** authors.



## Simulation of standards in products

There is a wide variety of options for using patterns in the most varied types of products, such as shoes, stationery, clothing, etc. The treatment of surfaces in the products reinforces the aesthetic function of the objects and makes it possible to differentiate them from other products available on the market.

From the creation of patterns inspired by the macroscopy of Angelim Rajado Amazonian wood, the possibility is created to promote and enhance the characteristics of Amazonian woods, as well as to add a conceptual and aesthetic differential to the products.

In order to highlight such information on the products, it is suggested the addition of explanatory labels in order to highlight the origin and creative process of the conception of visual patterns originated from the visual study of the macroscopy of Amazonian wood.

**Figure 28.** Simulation of application of some patterns in a product in the clothing area
**Source:** authors.

## Final considerations

Through the visual patterns generated as a result of the technical process of the surface design project, the possibility of using scientific knowledge about the anatomical elements of Amazonian tree species for the development of visual patterns was demonstrated.

Regarding the design of the modules, it was found that the anatomical elements, when worked in different sizes, alignment and colors, can generate new figures and visual perceptions derived from the interaction and composition of the elements, generating several options for visual patterns.

Although only one species was used in this research as inspiration, it is emphasized that further research can and should be developed with other species in order to explore their specific anatomical characteristics, in view of the great diversity of forest species.

Finally, it is concluded that knowledge about Amazonian woods can be explored in a different creative way through interdisciplinarity between Design and the field of Forest Sciences in favor of the valorization and dissemination of the Amazonian Forest wealth.

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