MAT-SUS: MATERIAL LIBRARY FOR TEACHING, RESEARCH AND EXTENSION

MAT-SUS: PROJETO DE MATERIOTECA SUSTENTÁVEL: ENSINO, PESQUISA E EXTENSÃO

MAT-SUS: ROYECTO DE BIBLIOTECA SOSTENIBLE: DOCENCIA, INVESTIGACIÓN Y EXTENSIÓN

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ABSTRACT
This article shows teaching, research and extension actions focusing on the use of materioteca. The main objective is to promote the dissemination of sustainability knowledge in projects, taking as a starting point the material selection process. This article presents a materioteca with a new concept, where in addition to samples of materials and technical information, it presents a complete report on the economic, social and environmental sustainability of each material (ESA). Complementary extension actions include the development of comics, videos, models and prototypes. The initial results of the present research demonstrated that it is possible to provide designers with an analysis of the relative sustainability of each material compared to similar ones, providing a very relevant set of design information.

KEYWORDS
Materials, Sustainability, Research, Teaching, Extension.

RESUMO
Este artigo aborda ações de ensino, pesquisa e extensão com foco no uso de materioteca. O objetivo principal é a promoção e disseminação do conhecimento da sustentabilidade em projetos, tendo como contexto norteador o processo de seleção de materiais. Apresenta-se a MAT-SUS, materioteca com um novo conceito, onde além de amostras de materiais e informações técnicas, apresenta-se um relatório completo sobre a sustentabilidade econômica, social e ambiental de cada material (ESA). Em paralelo, ações de pesquisa e extensão incluem o desenvolvimento de HQs, vídeos, modelos e protótipos. Os resultados são todos agrupados em site próprio, fornecendo aos projetistas uma análise da sustentabilidade relativa de cada material em comparação com outros similares, proporcionando um conjunto muito relevante de informações projetuais.

PALAVRAS-CHAVE
Materiais, Sustentabilidade, Pesquisa, Ensino, Extensão.

RESUMEN
Este artículo muestra acciones de enseñanza, investigación y extensión teniendo como foco el uso de materioteca. El objetivo principal es promover la difusión del conocimiento de sostenibilidad en proyectos, tomando como punto de partida el proceso de selección de materiales. Este artículo presenta una materioteca con un nuevo concepto, donde

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además de muestras de materiales e informaciones técnicas, presenta un informe completo sobre la sostenibilidad económica, social y ambiental de cada material (ESA). Las acciones de extensión complementarias incluyen el desarrollo de cómics, videos, modelos y prototipos. Los resultados iniciales de la presente investigación demostraron ser posible proporcionar a los diseñadores un análisis de la sostenibilidad relativa de cada material en comparación con otros similares, proporcionando un conjunto muy relevante de informaciones proyectuales.

PALABRAS CLAVE
Materiales, Sostenibilidad, Investigación, Enseñanza, Extensión.

1. INTRODUCTION

The project encompassing sustainability is already a reality, where the philosophy of continuous improvement is united with the increasing need to preserve natural resources, human quality of life, and current capitalism. This article shows an implemented proposal to contribute to this, using the concepts of material choice and sustainability triad, represented by the economic, social, and environmental dimensions.

As Ashby and Johnson (2011) comment, classification is the first step in bringing order to any scientific endeavor; it segregates an initially disordered population into groups that somehow have significant similarities. Because product design is a multidisciplinary activity, in essence, classification plays a very important role. "Design involves choice, and a choice is made from a huge range of ideas and data - among them, the choice of materials and processes" (ASHBY; JOHNSON, 2001, p. 123). Therefore, it is essential to this area that the classification occurs through a material library, a starting point for further analysis, such as performance in terms of comparative sustainability between materials.

Giorgi (2012) proposes material libraries as relevant structures whesre designers and designers can find innovative materials and technologies to increase their industrial projects and processes. In the educational field, material libraries contribute to professional training and practice in design, as they allow access to information for students and young professionals to expand their repertoire and knowledge.

In this case, the material library presented here is divided into the physical material library (material library itself), composed of different samples, the virtual material library (where traditional analyses and links with sustainable issues are present), and the construction library (models and prototypes demonstrating materials and related manufacturing techniques). Support actions include designing materials and processes in the format of Comic Stories and academic production of videos on materials and processes

2. REFERENCIAL

This project started in 2010, based on the ESE model found in Librelotto (2009), and was initially used for sustainability analysis in the construction industry. In this model, through the joint analysis of market pressures, given the performance and conduct, companies were classified according to predetermined terms: defeated, suffering, indifferent, responsible, opportunistic, and pioneering. In addition to the author's direct application in her doctoral thesis, the model was later used in two master's dissertations and several case studies, always with an initial focus on civil construction.

With the results obtained, analyzing the potential demonstrated in these case studies, Ferroli and Librelotto (2011) proposed to apply the ESE model in the analysis of the sustainability of the materials used in the manufacture of physical products for design (volumetric models and prototypes), adapting the method according to the specificity of the area. Thus, the performance axis evaluated the economic criterion of sustainability, the conduct axis evaluated the environmental criterion of sustainability, and the pressure axis evaluated the social criterion of sustainability. The position taken by the material used in the model or prototype in the cube determined the degree of "sustainability" according to a broad approach, covering the three variables: economic, social, and environmental.

From this, in 2012, the construction of the material library began with an emphasis on sustainability, starting with samples already available in the course laboratories. With resources from the project "Material Library with Emphasis on Sustainability a New Approach to the Selection of Materials Applied to the Project" of the PROEXT MEC SESU program, 2014, new samples and even part of the furniture were acquired. From then on, the maintenance of the physical part and preparation of the records of each material are carried out by scholarship holders, usually linked to the PIBIC-CNPq or Probolsas da Universidade program, renewed annually.

Based on the theoretical framework acquired in the initial projects, the constant bibliographic research was established as a starting point for permanent updating of the state of the art of the referred problem, followed by field research (visits to fairs, events, congresses, etc. whose subject addressed new materials and manufacturing processes). Each new scholarship student to the project must become familiar with the standard procedures for the synthesis of information, composition of sustainability variables, preparation of material classification requirements due to sustainability, study of the groups of materials in which the analyses were carried out, preparation of tests and sample validation procedures.

In the initial part of the research, the variables to be considered and their possible consequences were determined. These were modified and/or increased over time, always obeying possible and applicable measurements in real design situations. Due to the theme addressed, it was necessary to work with qualitative and quantitative variables, as well as those that, in a way, can be called mixed (neither thoroughly qualitative nor quantitative)

According to Severino (2007), the correct procedure in these cases is to refer to research as a qualitative or quantitative approach because, through these designations, one can refer to several methodological sets emphasizing one or the other approach. This is because it is difficult to conclude one purely qualitative or purely quantitative research, as happens especially when considering more heterogeneous groups, such as polymeric mixtures, mixed composite materials (natural and synthetic in the same block), or similarities/ particularities of natural materials, with their various species, types, and groups.

3. PROJECTS

3.1 Physical Material Library

The project activity, especially in design, is based on project methods. Regarding selecting materials, it can be challenging to determine the best approach for a project. This primarily depends on first identifying the actual problem of the project that needs to be solved. It involves complementary factors such as project team, previous knowledge, and method style preference (open, closed, semi-open).

The team in practical cases is often heterogeneous, which will bring an advantage and a better perception of the overall project. Therefore, a heterogeneous team is understood not only to be formed by professionals from different areas of graduation or specialization but also from different expertise. This is a limiting factor, and even an impossibility, in academia, especially in undergraduate courses, since they are usually people from the same class. There are exceptions in graduate studies, in design disciplines, where there are students from various basic backgrounds, such as engineering, design, architecture, etc.

There is a consensus among the various design methodologies that there are three specific periods: pre-conception, conception, and post-conception. In particular methods, the word design replaces conception with the same principle. The design team, aware of its qualities and diversities, must analyze the available methods and verify which will bring better results with less expenditure of resources (human, financial, structural, among others). In general, applying a design method effectively requires the simultaneous use of design tools, quality tools, and creativity techniques.

The method of Santos (2017), for example, allows greater freedom to the design team, while the method of Rozenfeld and others (2006) and Baxter (2011) present a more traditional and systematic structure. Due to the focus of this article, a detailed study of the design methods will not be carried out, and the bibliography on this aspect is quite rich for those interested. In part, the more "open" or "closed" nature of the design methods can be explained by the origin of the original training of the authors of each method. Those with design training usually use primarily qualitative approaches, while those with engineering training use quantitative approaches more frequently.

Another noteworthy feature is that methods considered “open ”allow material choices to be carried out in several steps. This resulted in the evolution of the MAEM-6F method (Material Choice Method in 6 Factors) to the FEM (Material Choice/Selection Tool) because as the end of the project approaches, the definitions will be more specific and increasingly definitive. So, the "choice" of materials is made: ferrous metals or processed wood, for instance. In this process of choosing, there is not a more technical definition yet. From then on, previously chosen materials are selected, such as defining AISI 304 stainless steel (ferrous metals) or MDF HD (processed woods).

The selection itself can begin with the analysis of materials that suit a common purpose (for example, flexible laminate, multilayer carton, glass, or polyethylene for packaging fruit juice), followed by the comparison of the appropriate production processes before making the final choice, thus adapting the processes to the materials (ASHBY; JOHNSON, 2011). Finally, one can work with a material already determined, where the knowledge of the materials will be valuable for defining processes of the product to be developed when proposing associations with other materials and planning its life cycle.

Akin and Pedgley (2015) relate this to the fundamental aspects necessary for a material library: (a) operational profile; (b) purpose and public; (c) content; (d) structure and form of display; (e) cataloging system, searching the collection and providing information about the materials. Different paths can be taken in each of these points, and the set of these decisions defines the characteristics and

functioning of the material library.

In a continuous process of assembly (by the acquisition of new materials), the physical part of the material library is located on the UFSC campus, in the Department of Architecture and Urbanism, next to Virtuhab, with free access to students, especially in areas related to product design activities, such as engineering, architecture and urbanism and design.

In this part, in addition to the samples themselves, reports have been made available containing properties, characteristics, application examples, demonstrations, etc., of the various groups of materials. The related activities integrate the research of new materials and new manufacturing processes, cataloging existing ones, and the development of catalog sheets with the life cycle of each material (virtual part). Scholarship students of the project also participate in material exhibition activities (at fairs and events) and visits to schools, aiming at initiating materials for young students, emphasizing the environmental issues of each material, such as degradation, energy consumption, recycling, and reuse possibilities, among others.

As shown in Figure 1, used for exemplification, the material samples preferably all have the same size (perimeter and thickness). When possible, they were obtained in this way to facilitate observations by the user, such as the relative weight between one type of material and another. Part A Figure 1 shows several different types of natural and processed wood. By simple tactile experimentation, students can compare the characteristics of each material, such as relative weight, texture, color, surface hardness, and others. In the case shown Figure 1, another advantage noticed is the possibility of comparing the cross-sections of different materials.

A common problem in material libraries, especially academic ones, refers to physical space, which is usually limited. Virtanen et al. (2017), by some means, touch on the subject when commenting on the differences between the material libraries considered "commercial" and the academic ones. In commercials, it is typical to have two types of which, in both cases, access is generally restricted to members and commonly involves a financial part, charging visitation or association fees via monthly payments. The other types of commercial libraries are those linked to manufacturers and suppliers of materials, practically with the same characteristics as the previous ones but with restricted use.

There are also material libraries called private or professional "collections", which are usually set up and maintained by offices or companies, and alike have restricted access, directed to employees. Institutional or academic material libraries, on the other hand, usually have an educational profile and are organized by research groups or courses. In the case shown in this article.

Figure 1: Physical part of the material library.
Source: Omitted for review.

3.2 Material library with an emphasis on sustainability – virtual part of the material library y

The virtual part of the material library is where users find the general data of the samples and their relationship with the emphasis on sustainability, where it seeks to relate the process of choosing the materials with the factors listed in Librelotto et al. (2012), where the process is based on:

- Manufacturing and productive factors;
- Market and social factors;
- Economic and financial factors;
- Aesthetic and general presentation factors;
- Ergonomic and general safety factors;
- Environmental and ecological factors.

The objective is to fill the gap in the current existing material libraries by providing the user with, in addition to samples and reports containing properties, characteristics, application examples, demonstrations, etc. (common to existing material libraries), the analysis of the sustainability of said material, compared to other materials directly competing for each specific application. This analysis includes social, economic and environmental aspects.

Figure 2 exemplifies the digital part of the sustainable material library. This web page contains didactic material, which complements the physical samples made available in the laboratory. In practice, students find in the virtual part of the material library the following information about each material: concept, history, specific properties, physicochemical properties, thermal properties, mechanical properties, classification, production processes, manufacturing processes, main uses, disposal, recycling, sustainability analysis, and leading suppliers. The last image of the figure shows an example of the report, which is all produced with the same graphic design.

Figure 2: Virtual part of the material library.
Source: Omitted for review.

3.3 Complementary projects to the material library

During the years of use of the material library, some projects were developed as users identified new needs. Among these needs, the following stand out:

1) Construction of models and prototypes. The models and prototypes are built in specific classes, with the participation of both regularly enrolled undergraduate and graduate students and others through extension actions. Figure 3 shows four of these models. The first is a prototype built with bamboo and was carried out in a practical workshop with the participation of undergraduate and graduate students, together with extension workers and researchers. The second is a prototype made with resources from a research project. This is a "floating" house intended for areas of potential flood risk. Its construction was outsourced, but the operational tests were all carried out in experimental classes. The third image shows a steel frame construction, whose material was donated by the company Center Steel, with the construction carried out in an experimental class, and the fourth image is of a wood frame, whose material was donated by MF Madeiras, with construction also in an experimental class.

Figure 3: Construction Library Projects.
Source: Omitted for review.

2) Availability of the content of materials and manufacturing processes in HQ format. It is the development of a series of publications for teaching sustainable materials and processes that meet the demands of a new generation of design students in the form of comic books. For the teaching of materials applied in the products, combining it with sustainability requirements, an approach that reaches the target audience (students related to the project areas) more forcefully and follows the communication language of the stakeholders and decision-makers became urgent and necessary. Although communication associated with comics is not recent, such an approach for didactic purposes is not common yet, especially when integrated into the virtual environment and the teaching/learning of materials applied to projects. The project is already in its second year, and Figure 4 illustrates some images.

The first image of Figure 4 shows a general process application in choosing materials; the second image refers to the classification of materials usually used; the third and fourth images address the study located in a material, in this case, ceramic. The other materials are still being designed.

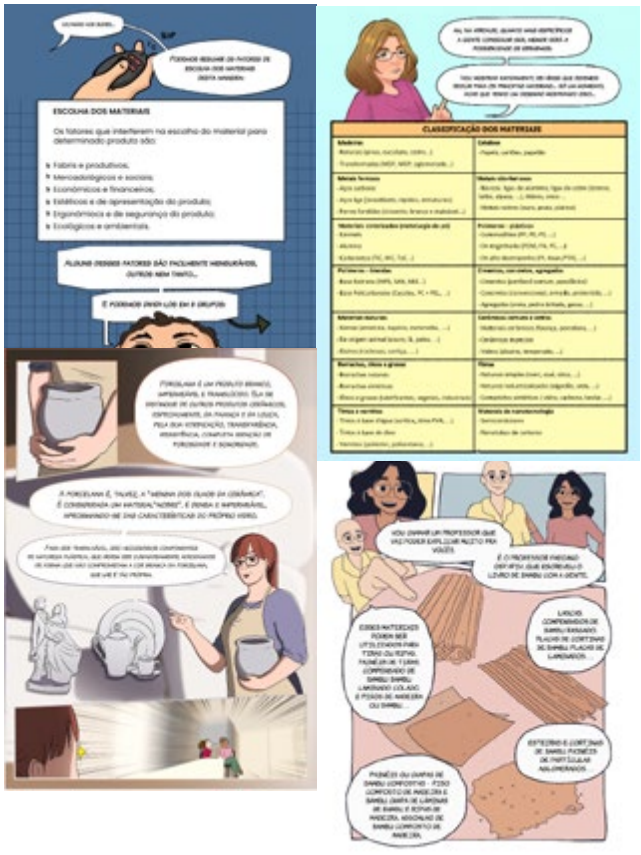

Figure 4: Material content and processes in comics format.
Source: Omitted for review.

3) Development of didactic videos on materials and processes. The videos are developed by the students of the participating classes, with guidance in the classroom. They are presented, corrected, and made available on the website if authorized by the authors. The first image in Figure 5 shows how the videos are made available, and the second image presents an example of a video.

Figure 5. Complementary actions - videos.
Source: Omitted for review.

4. FINAL REMARKS

The article aimed to show some projects developed within the scope of the laboratory (omitted for evaluation) of UFSC (Federal University of Santa Catarina), focusing on projects linked to the material library.

The need for a material library (in its physical and virtual versions) is confirmed when one understands the process of choosing such to be more than considering technical and productive attributes. A good product must meet the needs of all user groups, involving productive, economic, ergonomic, social, environmental, and aesthetic aspects, and the materials suitable for this model must all comply.

The complementary projects of videos, comic book production, and construction/assembly of prototypes have proved, over the years of application in undergraduate and graduate classes, to be an essential didactic resource, along with an integrating element between research, teaching, and extension. Mainly because all workshops offered for teaching purposes are prepared or presented by extension or scientific initiation students, in addition to the supervision of master's and doctoral students.

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PCMF: conceptualization, formal analysis, funding acquisition, research, methodology, project management, visualization, writing - original draft, writing - revision & editing.

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