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CRAFTS, DESIGN AND MATERIALS ENGINEERING, A POSSIBLE DIALOGUE

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ABSTRACT

The interaction between Materials Engineering, Design and Social Sciences was the key point for the development of this article. The article evidences the planning, development and insertion of a new composite in the productive chain of a small family company, from empirical techniques, in the production of sacred artifacts in plaster. The developed composite comes from the combination of a brewing residue (diatomaceous earth) and plaster. The project aims at territorial valorization without discarding the cultural, social and economic aspects so that the demands are processed and later applied according to the local demand.

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INTRODUCTION

This article aims to analyze the feasibility of developing a composite of plaster and diatomaceous earth, as well as its application in the productive chain of a family company that produces sacred artifacts in plaster. The study aimed to minimize the resources used as feedstock, water and gypsum, as well as the possibility of reducing price and cost, in order to provide an increase in the company's income generation. The research was developed in the Municipality of Aparecida, marked by religious tourism throughout the year, the place attracts the eye of tourists and dealers, both locals and other regions and even other countries. Some local products are rich in meanings, and can arouse the symbolic sensitivity of those who visit the place. In 2014, the municipality of Aparecida had a record of 56 sacred artifacts companies, but local residents report the presence of many "backyard" companies that produce sacred images in plaster in an informal manner, without registration in the city hall. Some of these companies have their creation linked to unemployment or the facility in marketing such images in the region. The development of a new material using gypsum added to a residue, is the result of the great amount of companies that produce sacred artifacts in gypsum, already inserted in the municipality. The residue mentioned here, the diatomaceous earth, comes from the production of beer, and this, despite being an organic waste, does not have an adequate disposal. CervBrasil (Brazilian Association of the Beer Industry) states that Brazil ranks third in the ranking of beer production in the world, which is equivalent to approximately 14 billion liters per year. Only in the year 2016, its financial movement was about R$ 77 billion reais.

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One of the problems that has been encountered with the production of beer and chopp is the disposal of its filtering element in the production, diatomaceous earth, also called kiesselguhr. This element is a mineral residue, organic, of low specific mass and of very short useful life that does not have viability of reutilization like media filter due to the saturation of the material. Failure to reuse this material by the brewing industry will result in improper disposal of the material, thereby damaging the environment. The motivation for the reuse planning of this residue was due to the identification of two main needs: the absence of an adequate destination for the disposal of this material that is produced in large scale in the Brazilian industry and the lack of improvements in the production process of the artifact religious to minimize resources and, consequently, cost.

MATERIALS AND METHODS

The research was developed in a family company that produces sacred artifacts in plaster and allowed the interaction of three disciplines, namely: Materials Engineering, Design and Social Sciences. The Materials Engineering allows to work with the analyzes of the raw material of the composite from the microstructural characterization; Design allows the understanding of the production chain as well as the steps taken during the process of production of the religious artifact. The Social Sciences contribute to the socio-technical analysis based on the perspective of the Actor-Network Theory (ANT). Having defined the theoretical contribution to the construction of the research, an important step began: exploratory visits at the brewery and family business. In order to map the production processes and perform semi-structured interviews, the visits allow a better visualization of the network, the technique and the actors involved in the process. To start the process in laboratory, which has the purpose of preparing the test samples, it was necessary to calcination the diatomaceous earth collected in the brewery. The feasibility of this stage is due to the use of aoven Mufla at 800 ° C, this equipment is used in laboratories and reaches high temperatures, and can vary from 200 ° C to 1400 ° C. The understanding of the production process allowed the preparation of the test pieces, with different proportions of addition of the residue in gypsum being the variations of 0%, 5%, 10% and 15%.

After these processes, still in laboratory an optical microscopy (OM), scanning electron microscopy (SEM) and dispersive x-ray detector (EDS) were performed for topographic and morphological characterization of the obtained material. Other steps observed during the sociotechnical analysis were also put to the test, the sanding and waterproofing of the pieces were done, as well as its painting. It is important to emphasize that all the steps mentioned here were put into practice so that it was possible to prove the efficiency of the material. After the feasibility analysis of the utilization and commercialization of this artifact, the company's economy was surveyed, its ratio of plaster and water proportion as well as its direct relation with the final product, being this an artifact to potentiator as a product of lower environmental impact in relation to its competitors.

Theoretical Reference

"To speak of interdisciplinarity is to speak of the relation between disciplines" (Couto, 2014, p.87). Raynaut (2011) points that out the current scenario have the need to resort to new paradigms, new categories of thought, new research methodologies and new teaching formats. Japiassu (1994) understands that interdisciplinary work is if concretize through the interaction of disciplines, from the simple communication of ideas to the mutual integration of concepts (interdisciplinary contacts), of epistemology and methodology, procedures, data and organization of research (JAPIASSU, 1994, p.2). It is not necessary to have specialty and broad knowledge in all the disciplines involved, but, pay attention to what each one can offer to contribute to a given project. According to Cardoso (1998), design is configured as a relevant source of the material culture of a society for its ability to transmit information and has the ability to act at all stages of the process of making an artifact. For Bonsiepe (2012), this participation of the design in different functions makes it interdisciplinary, because it is concerned with aspects related to aesthetic quality and use, but also to the technical-functional requirements and technical-economic constraints (Bonsiepe, 2012, p.61). When thinking the practice of design in peripheral countries, as Bonsiepe (2012) observes, it is necessary to develop its own model project, which minimizes the use of resources, mainly energetic, with purpose in order to achieve economic growth. In the case of the family company, the creation of a new material, besides taking advantage of residue, would allow the reduction of some resources during the preparation of the raw material of the artifact without affecting its appearance. Bonsiepe (2012) believes that in addition to providing satisfaction and meeting some consumption needs, it is up to design to provide people with satisfaction for what they will produce. According to Raynaut (2011), for have collaboration between disciplines of different fields - material and immaterial - it is necessary to define the frame of reference from which they will interact, in this way, identify the different fields of observation in order to analyze how the properties structural and functional are articulated, if combine and confronted each other. According to Fontana et al (2012), collaboration in design is understood as reciprocity in the involvement between people, whether they are from the same knowledge area or not, in order to find solutions that are able to satisfy all interested parties. Material Engineering is fundamental for the study of this new composite that uses waste from brewing added to the gypsum, raw material already used in the production to be studied.

We live in a world of materials. It is materials that give substance to everything we see and touch. Our species - Homo sapiens - is different from others, perhaps more significantly by the ability to project - produce "things" from materials - and by the ability to see more of an object than just its appearance. Objects can have meaning, arouse associations, or be signs of more abstract ideas. Projected objects, both symbolic and utilitarian, precede any recorded language - and give us the earliest evidence of a cultural society and symbolic reasoning. (ASHBY, JOHNSON, 2010, p.3). Callister (2002 p.359) defines composite as "any multiphase material that exhibits a significant proportion of the properties of both phases that constitute, so a better combination of properties is obtained."By this is meant as a composite a material which has a matrix and a reinforcement which may be the combination of two or more materials having physically or chemically distinct properties. 'Pó-de-mico' or simply 'mico', 'estopa' or 'sapóleo' are popular denominations that recognize the "sponjilitos" or diatomaceous earth throughout the interior of the State of São Paulo. They are also known as Kieselguhr (Germany), Moler (Denmark), Trípoli (Russia) and Gais (France), which constitute a group of pozolanas characterized by materials of organogenic origin. (Montanheiro et al., 2002 apud Mehta & Monteiro, 1994 p.4). However, the application of this composite occurs in a complex way, because it is a material developed in a laboratory that will be applied to the reality of a family company that does not have the same structure. Some factors are paramount for the sociotechnical analysis of the application of this composite in the field: adaptation of techniques and instruments, the interests of the involved, relation of production x cost x time, instruction and training of employees to deal with new material employed etc.

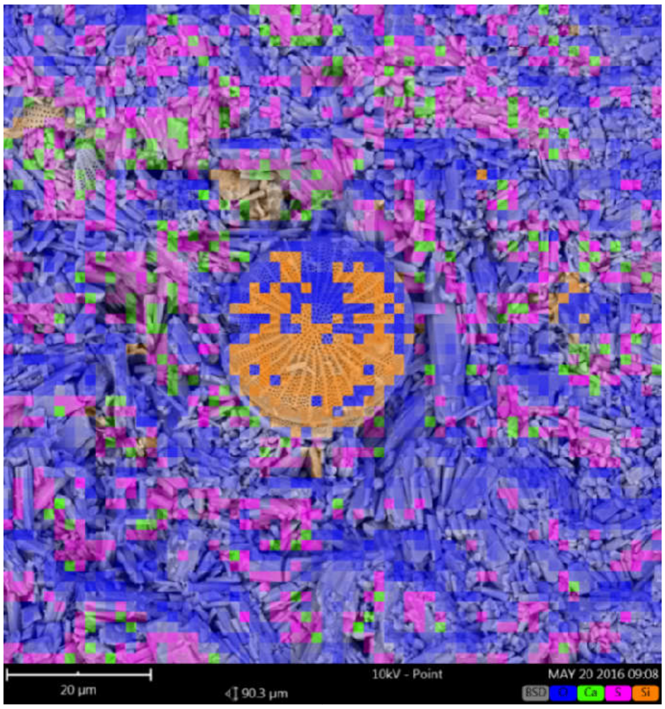
DEVELOPMENT (RESULTS AND DISCUSSIONS)

The diffusion of local religiosity is a result of materialization through the projection into artifacts. This reality of the municipality contemplates the residents, structuring an economy of opportunities for local development and income generation, which highlights the relationship between company and municipality and its interdependence for religious tourism. The sociotechnical analysis provided a perception of the productive process in execution, emphasizing that the predominance during the manufacturing process is manual where the know-how stands out in front of pre-established standards and / or standards for the development of such artifacts. It is possible to observe that the identity of the company is structured around its founders, these, no longer active as active members in the manufacturing process. A small company, with twenty years of experience in the market, grew up in the back of the house house and provide to the idealizers encouraging other family members to organize themselves in a professional way. The family structure and reduced allowed the dissemination of the empirical technique and knowledge of the productive process, the continuity of know-how.

The on-site visits were structured for mapping and detailing the production process and raw material collection. In the brewery it was possible to observe the production process until the discart of the waste, its storage and transport. In the company of sacred artifacts it was possible to understand the production process to initiate the development of the composite in the laboratory. With visits and interviews carried out in the sacred artifact company, it can be observed that the containers used for dosing water and plaster are improvised, plastic pots that do not have units of measurement and even the use of their own hands for measurement. The mixture is also made with improvised equipment, something similar to a spatula or hands. It is also noted that no PPE (personal protective equipment) is used during all stages of the production process, which are empirical and have commonly used equipment. The brewing in the company visited occurs once a month, the amount of residue manufactured varies according to the amount of beer produced. The lack of preparation for disposal of the diatomaceous earth is evident. After the beer production process, the waste is deposited in ordinary buckets which, because they do not have an appropriate disposal destination, are sent to small farmers and inserted into animal feed. After the raw material was collected, the analysis of the materials under study was started, which made possible allowed a better perception of the materials to be explored.

Optical microscopy revealed the existence of fungi and distinct organic matter in the composition of the inputs resulting from the brewing process, these used as filter elements. The residue that arrives in the laboratory for study is pasty, a mixture of diatomaceous earth and organic material, so that it can be added to the plaster and give rise to new material, it must return to its physical state of dust. Two different methods were then used, the first subjected the residue to an greenhouse at 180 ° C, the second, the most effective procedure to be adopted by the research, was to subject the residue to a muffle at 800 ° C. After this process, were developed samples to analyze the composite. The gypsum and water mixing pattern is: 100 g of water is used to 100 g of gypsum, with being stipulated the proportions of additions of diatomaceous earth charge of 0%, 5%, 10% and 15% in gypsum. Several tests were carried out that possibilite to observe the behavior of the materials and the ideal proportions for composite development.

In the first tests it was possible to observe that, after the drying process, the samples decreased its volume in the mold when diatomaceous earth was added in relation to pure gypsum. Another point worth mentioning is that the mixture with diatomaceous earth repels the water, which allows the restructuring of the proportion of its use in the composite. With this observation were made several tests reducing the addition of water in the material, making it arrive the ideal proportion that is: for each 100g of plaster will be used 60ml of water. This proportion of water for gypsum enables a saving of up to 40% of water for the production of artifacts that insert diatomaceous earth compared to the use of pure gypsum only.
After defining the ideal proportion of the mixture (100 g of plaster to 60 ml of water), the material underwent a morphological and topographic analysis. The tools used were a Scanning Electron Microscope (SEM) and chemical with Energy Dispersive X-Ray Detector (EDS), in different proportions of diatomaceous earth addition in gypsum.



Source: Authors 2016

Figure 1. EDS Plaster and Diatomaceous Earths

In Figure 1 it is possible to observe a good acceptance of the residue incorporated in the gypsum, both aesthetically and chemically, once the material was configured homogeneous and the chemical elements that compose it are compatible. With the SEM and EDS analysis the morphological distribution of the particles and their topographic characteristics were observed, the materials are affiliates through intermolecular interactions mainly between oxygen and silicon atoms, which overlap in the composition of the diatomaceous earth. The chemical interaction provided a homogeneous material allowing its applicability with the reduction of approximately 40% in the use of water and 15% of gypsum, which directly implies the reduction of costs and environmental impact during the manufacturing process of such artifacts. As the material presented a homogeneous surface finish and able to meet the aesthetic needs for the production of sacred artifacts, the sanding and subsequent painting of the sample was done. The new composite, meets expectations and accept sink well. With regard to economic issues, the material will imply for the company a reduction of up to 15% in the use of the gypsum matrix. Currently, 20 bags of gypsum of 40kg each are used, with the addition of diatomaceous earth in the production process, reducing to 17 bags and using water would be reduced by 40%. The references here are from a small company, which uses gypsum for the production of sacred artifacts, but this large-scale application is capable of promoting a significant economic, environmental and social change for production. It is emphasized here that gypsum is a raw material used in several sectors not only in Brazil, but also the breweries and their residues can be found in several regions of the world.

Final Considerations

The interdisciplinarity proposed in this work was essential for the identification of needs and problems caused within the sociotechnical network analyzed here. In this case, Materials Engineering, through fundamentals and techniques that made possible the confection of the composite from the mixture of two materials with different properties (gypsum and diatomaceous earth). The Social Sciences, using the Actor-Network Theory to mark information of all the elements that are arranged in this network. And ultimately, Design as an interdisciplinary field capable of working in association with these disciplines in order to identify, mediate and mobilize interests at all stages of the production process. Of extreme importance for this research, we emphasize the sociotechnical analysis that allowed a broad understanding of the relationship between the human and nonhuman actors of this network. It emphasizes the importance of hearing the voice of the artifacts, both in terms of physical material composition and intangibles directly related to the production process (stages, technology and deadlines). In addition, this analysis allowed the identification of controversies in the different fields of research. The laboratory, which presents all necessary structure for the development and study of this material, which requires not only adequate space, but also technical qualification and sophisticated equipment. And the other, the family business, which does not have basic items such as personal safety equipment, adequate physical space, instruments that offer laboratory-like efficiency and the necessary training to work on this new material that causes significant changes in the production chain when introduced. Therefore, it was noticed the need to adapt the material developed in the laboratory for its application in the field. Considering basic elements, from the simple units of measurement established by the employees (number of "hands of gypsum", number of plastic pots of margarine) to the possibility of using basic equipment that concerns the safety of employees or even instruments that facilitate the production process. This new production model needs a cautious evaluation in order to bring benefits to the company, either in the reduction of time or resources used with negative or positive interference in productivity.

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