REALIZATION PHASE OF MODEL IN TERMS OF ECODESIGN

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Abstract: Making a model of a product represents an important stage in product design. Model would include representation of the shape, size, color, ergonomics and also product functions. This stage involves a financial effort, model requiring time, energy, consumables. This paper presents results of experimental research conducted by the ecodesign light on the identification of solutions for replacing supplies scarce, expensive. Based on studies of the realization of models was identified a simple and cheap solution which consists in using silica silicate "water glass" as hardener in achieving models on 3D Printer machine. The solution found can be applied in case of some models of waste resulting from wood processing (sawdust) using "water glass" as a binder.
Key words: model, design, ecodesign, silica silicate

1. INTRODUCTION

The model represents an important phase in designing an industrial product. The making of the model supposes a phase of preparation, respectively a phase of analyze, which means: analyzing the making costs and conditions, establishing waste management, identifying the reduction potentials, anticipating the legal decisions, the macro and micro geometry of the proposed form, the gauge, the functions, the ergonomics and chromatics of the product. The model creates for the designer the possibility of checking the ideas and solutions of the proposed project, and for the beneficiary the possibility to understand the concept proposed by the designer. Taking into account that designers are involved during the whole life of a product, they have to guarantee the best ecological solutions concerning the impact of the products on the environment, including the ecological evaluation of the modeling phase (Pralea et al., 2009). So, it will be taken into consideration the shape of the product and the marks, the finishing of the surfaces are composed of, the assembling possibilities of the component marks, the scale at which the model is being made at, the materials used to make the model, the technological procedures through which the model is made and also the equipments used for making the model (energy consumption, materials etc.) (Pralea et al., 2009). Taking into consideration the products circle of life, decisions are taken which permit obtaining the most important ecological and economical benefits and also the identification of the potentials specific to each phase of the product's life circle (Pralea, 2009). The managerial decision concerning the modality to make the model is based on the evaluation of cost reduction possibilities.

2. THE ACTUAL PROBLEM

The ECODESIGN products fulfill certain criteria: recycling capability, low consumption of materials and energy, durability, avoiding toxic materials, optimal advantages for the customer, and use of regional resources. The entire evolution of the product, starting with the fabrication till elimination, must be kept under observation in order to develop solutions which are most profitable and most compatible with the surrounding environment. The products must be designed and made, even in the modeling phase, so that they become profitable, compatible with the surrounding environment but also innovating (Ecodesign, Grant CNCSIS, 2007). To achieve such objectives the followings must be taken into consideration: the innovations of the product, cost reduction, high advantages for the customers, regional implications, image improvement, thrust and prestige. Although the technologies used to make the models are advanced, there are problems concerning the procurement of the consumables and their cost price (Pralea et al., 2009). A permanent identification of alternative, comfortable and cheap solutions is requested and also finding new substances and/or materials, usable in the modeling phase.

3. INTERNATIONAL LEVEL

Starting with these facts it was searched the optimal solution to replace a material which is hard to be procured, it is adverse from purchasing point of view and expensive from price point of view, the infiltrant Z-Bond 101. Experiments to replace the infiltrant Z-Bond 101 were made, used as a hardener for the models made on the 3D printer Zprinter 310 Plus, made out of ZP 131 powder, with a hardener which is a common substance, easy to procure, the sodium silicate (Stangaciu, 2008). This substance was used, due to its capacity of absorbing water from the air, in the First World War it was used to absorb the gas and vapors which penetrated the gas masks, and in the Second World War it was used to protect the penicillin and the military equipments from moisture (Etrader, 2010).

4. ORIGINARY MAIN IDEA

The originality of the idea is the use of the substance sodium silicate's properties in modeling: increases the cleaning action of the alkaline substances, protects the surfaces made out of aluminum or tin sheet from the corrosive action of the alkaline substances, it is easily soluble in water and it has a very good emulsion and moisture action, it is used by foundries as a binder when preparing the forms and cores, for the packaging of the products in order to maintain a dry atmosphere, in constructions to assure long life water proof qualities and durability for the concrete. This substance, sodium silicate, penetrates the concrete and reacts with the calcium from the concrete and the water, in order to form a hydrate gel of calcium silicate non solvable in water, in order to fill the cracks, pores and capillaries. The gel provides a barrier in the surface layer against the penetration of the water and other impurities like the chlorine ions. By exploiting the use of this substance, it was applied also to the modeling stage made on the 3D dust printer ZP131. During the experiments the "water glass" a soluble sodium silicate was used. The name comes from the German "wasserglass", due to the fact that the sodium silicate is a component of glass. Technical dates of the sodium silicate: relative density: 1,45 – 1,55 kg/dm^3, silicate dioxide (% min) 25 $SI0_2$, total alkalinity (%, max) $14NA_2O$, module 1,9 – 2,5 (Kemikal Epitoanyagipari, 2010). The sodium silicate is presented like a dens liquid, of a yellow color, transparent and with a characteristic smell. The boiling point of the water glass is at almost 100^{0}C, the pressure of the vapours is of 23mbar, with a pH over 12 and an unlimited solubility in water. In contact with vegetable or animal organism (skin, cotton), the water glass disintegrates them. It produces corrosion on glass, glaze or china surfaces, materials used in the process of manufacturing finite products or prototypes.

5. RESEARCH METODOLOGY

Using the water glass, its application on different surfaces was tested, in various ways, in order to study the way it reacts. So in figure 1 the sodium silicate solution was applied, by brush, on a pressed cardboard surface (pasteboard). In area A the application of non diluted sodium silicate solution and in area B – the application of diluted sodium silicate (50% water); The application of the diluted sodium silicate solution, figure 1 B, proves that in case the solution is diluted, the penetration in the analyzed surface of the pressed cardboard is better, resulting a surface with superior properties from the uniformity of the applied protection layer's point of view. In all the three cases presented in figure 2 A, B, and C the increasing of the object's durability was obtained. The obtained durability is similar, in a proportion of 75 – 80% to the one resulting by the use of the Z bond hardener. By testing, several applying ways of the sodium silicate were tried: by sinking (immersion) or brushing. Concentrated and diluted solutions were used.

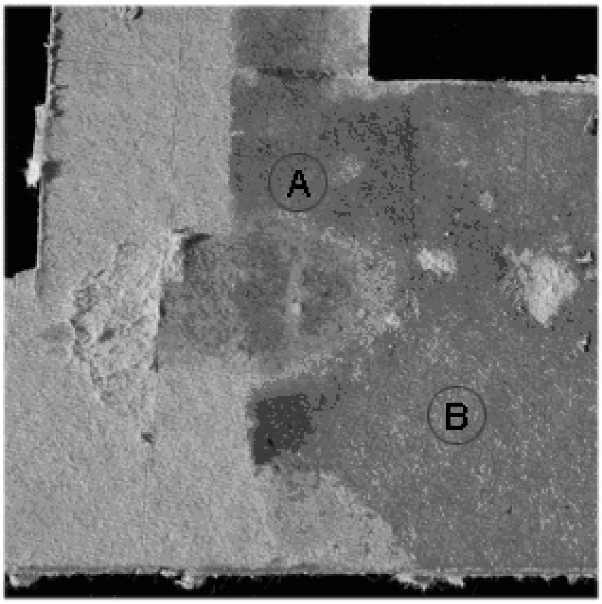

Fig. 1. Applying water glass, by brushing, on a surface of pressed cardboard (pasteboard)

Fig. 2. The use of sodium silicate as a replacement of the infiltrant Z-bond 101

The experiments confirmed the possibility of replacing the infiltrant Z-Bond 101 with sodium silicate solution. By analyzing the samples obtained after treating them with sodium silicate solution it was observed that the optimal method to apply the hardener layer is by brushing, and the optimal concentration of the sodium silicate solution and water is of 50%. The applying method used by brushing, permits the object, made out of ZP 131 powder, to absorb the solution better by penetrating the dust particles. The 50% water dilution increases the possibilities of the solution to penetrate the material, thus strengthening the piece.

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Fig. 3. Object made by the use of 3D printer Zprinter 310 Plus, from ZP131 powder, where the hardener layer of sodium silicate, solution 50%, was applied by brush

Figure 3 presents an object made using 3D printer Zprinter 310 Plus, from ZP 131 powder where the applying of the hardener layer of sodium silicate solution with a 50% concentration was made by brushing. 3 layers of water glass were applied, in order to achieve a hardness which permits its polishing. Necessary drying time: 15 minutes for the first layer, 20 minutes for the second and the third ones. The treatment to increase the surface hardness by applying the sodium silicate solution was made at room temperature (18 -20 degrees Celsius). The binder qualities of the sodium silicate were tested by creating a mix composed of sawdust and solution of 50% sodium silicate (figure 4). This mixture was later applied to a surface of fir wood, drying time 48-56 hours. In the modeling domain, this property of the sodium silicate, of a good binder, can be used in the making of some products like models of sawdust or fine sawdust. Moulds can be made, representing the negative shape of the product, in which the mixture of sawdust or fine sawdust with sodium silicate dilution can be poured. A favorable aspect in using water glass as a binder is the realization of surfaces with a special aesthetic effect. Thus, various forms and roughness levels can be made (figure 4).

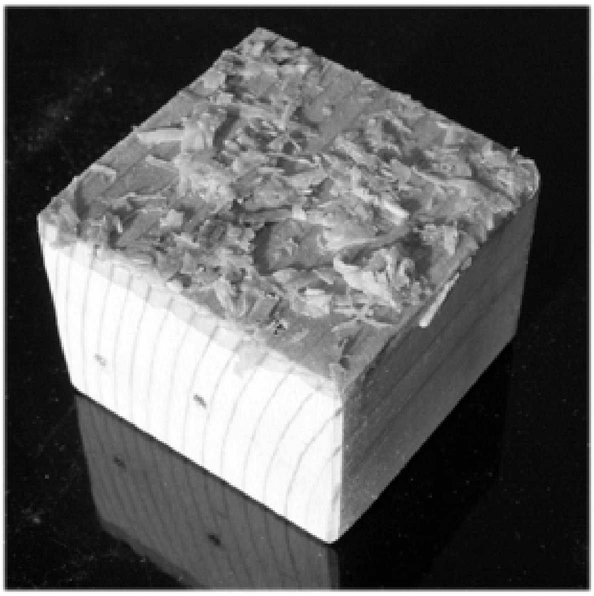

Fig. 4. Surface formed by a mixture of sawdust and water glass

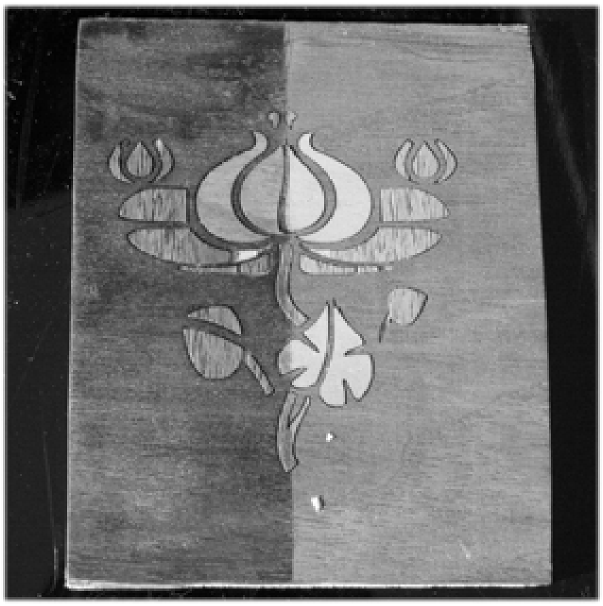

Fig. 5. The use water glass as a varnishing protection

Testing the possibility of replacing varnishing protection for wooden surfaces is presented in figure 5. In the left side of the figure there is a portion on which it was applied by brushing a layer of concentrated sodium silicate solution. The effect obtained is a protected semi-shiny surface. Drying time at room temperature 10 -15 minutes; the same test made on a surface of lime tree wood is presented in figure 6. In the central zone 2 layers of water glass were applied, obtaining an effect similar to the one obtained by using varnishing for wood. The result of using a mixture of sawdust from soft essence wood with sodium silicate solution is presented in figure 7. After drying, approximately 50 hours a material of medium roughness resulted. In figure 8 the silicate granules re-crystallizing in the atmosphere (after a while) can be observed. The re-crystallizing of sodium silicate on the analyzed surface could be a negative aspect in its usage.

At the prototype presented in the figure 9, the infiltration was achieved also with the sodium silicate. The prototype made of ZP 131 dust, presents similar results as in the case with the Z-Bond infiltration. The result of the test shows that the prototype doesn't support the second layer (saturation phenomenon) of substance. This case reveals a time, manual labour and substance economy.

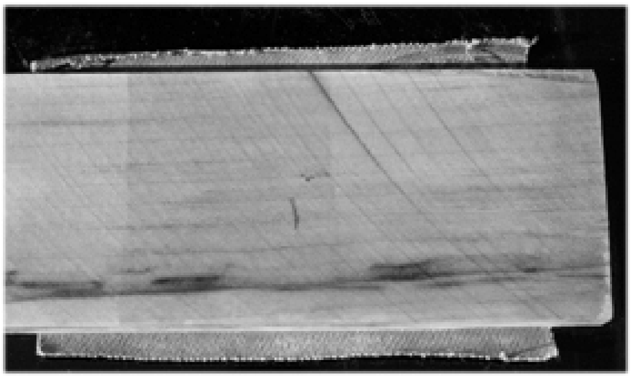

Fig. 6. Applying water glass on tree wood

Fig. 7. Mixture of sawdust and water glass

The figure 10 shows a detail of the prototype presented in figure 9 by witch it show the surface level (shade difference) before and after the intervention with sodium silicate. The sodium silicate intervention, as a protection layer on the piece surface, piece made of veneer (wood previously treated), was reanalyzed after a period of 5 months and was discovered that the left part of the piece that was treated with a concentrated solution has sodium silicate crystals (figure 11) and the right part, witch was treated with a weak solution, has a nice, soft surface, as good as if it has been treated with wood varnish.

Fig. 8. Detailed mixture of sawdust and water glass where silicate granules can be observed

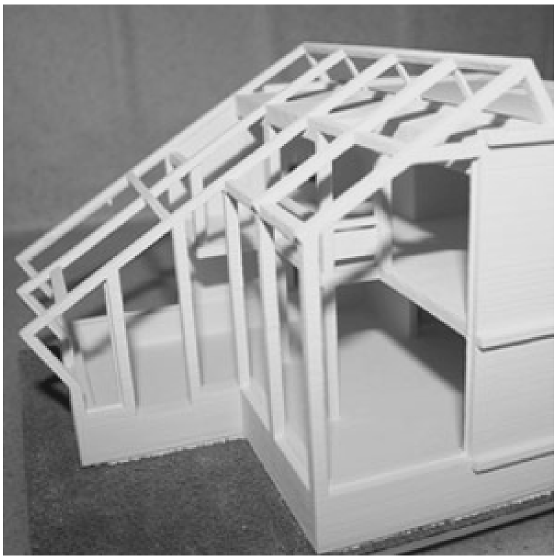

Fig. 9 – Prototype on witch was applied a single layer of sodium silicate

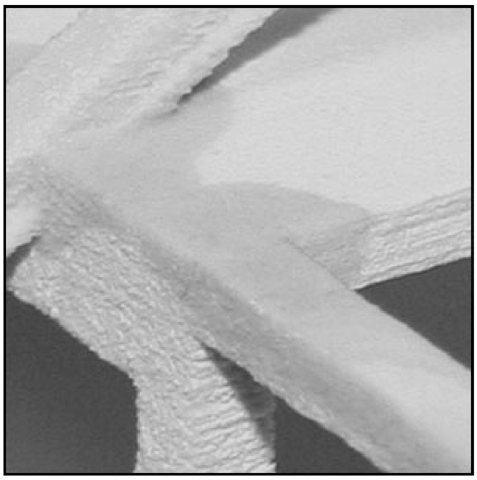

Fig. 10 – Detail of a layer with sodium silicate

If a natural wood structure is treated by applying a layer of sodium silicate with a concentration of 50%, this substance penetrates the fiber structure of the wood, resulting in a smoother, shiner surface.

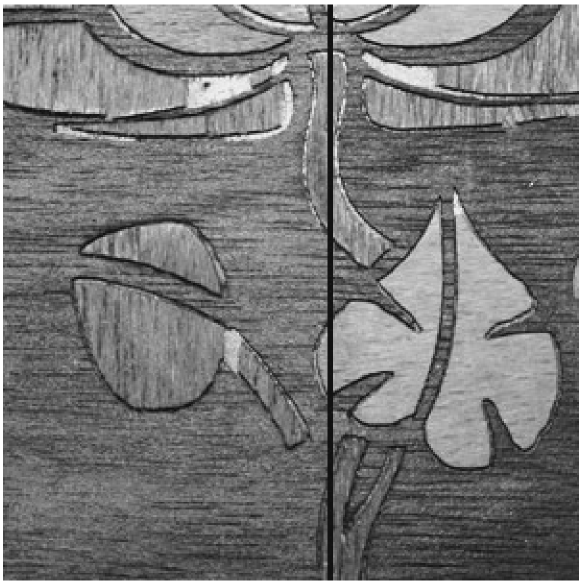

Fig. 11 – Highlighting the state of the veneer surface treated with sodium silicate after 5 months

Fig. 12 – Crystals of sodium silicate revealed on veneer surface, witch was treated with sodium silicate, after 5 months (in detail fig. 11)

Tests presented in pictures 1-13 demonstrate the fact that a continuous activity of research must be in progress for execution of the prototypes, so that this could fit the ecodesign basis. This theoretical research could carry on to some results that could allow the achievement of a low-cost prototype and indicate some intermediates products or technologies that could carry on to the achievement of optimal conditions in manufacturing process of those prototypes. The analysis of materials and indicated technologies as a result of the research must fit not only the esthetic requirements but also the functional and ergonomical specifications proposed by the designer. Therefore by usage of the sodium silicate, material known and used in different domains of activity long time ago, it creates the possibility of making a prototype with a lower cost of production and in the same time with the same technological conditions (figure 3). Usage of this substance (common, cheap) demonstrates that through research could open new possibilities of making prototypes and new types of reference terms with different finishing and cheap to make. This material presents the benefit that could be easy to get and cheaper than the sustaining Z-bond. The solution used, opens new ecological possibilities to the designer in making of prototypes. The usage of sodium silicate, a cheaper substance than the previous one, the sustaining Z-bond, opens new possibilities of prototyping by experimenting this substance in usage of the technological clipping resulted from technological process can be reused in making of some parts or some surfaces with an esthetical value (figures 4, 7, 8). From the ecological point of view, this assumes proofing a prototype as being ecological not only by the fact that it uses wastes (sawdust, fine sawdust), but also the fact that it can produce concepts of parts by pouring them into molds with a admixture of sawdust, fine sawdust that could have as binder the sodium silicate or a different substance that could fit to the esthetical aspect, ergonomic, economic and ecologic. The purpose of the paper is to show that in every activity we can cut in ecological. Therefore in the modeling/prototyping faze choosing material must fit the requirements indicated above (figure 14) but nevertheless the designer should keep in mind the ecological implication of the material. Every decision taken in prototyping a product must demonstrate the respect for the environment. Achieving a modeling phase draws in the designer into providing the best solutions for users and producers about recycling/elimination of wastes. The designer must be in permanent searching of new optimal solution for client and environment. Prototyping means therefore an important phase in achieving a product, phase witch assumes the identification.

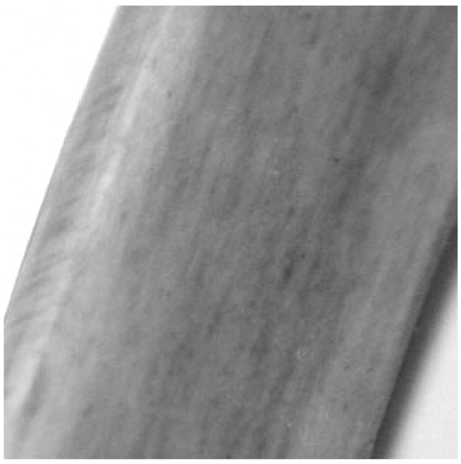

Fig. 13 – Map out the surface treated with sodium silicate, after 5 months, of a landmark made of untreated wood

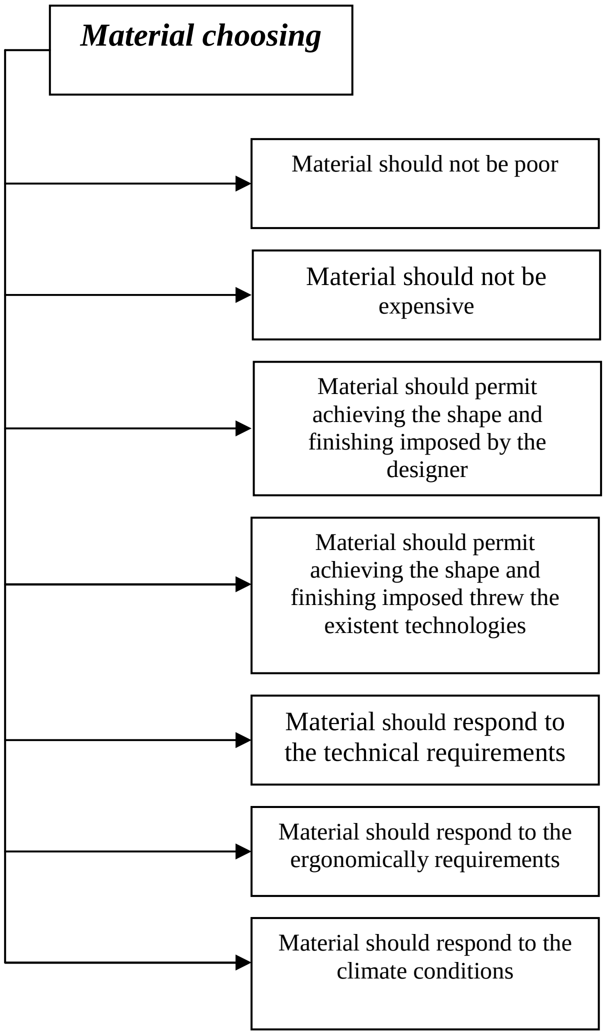

Fig. 14 – Conditions imposed on material choice

6. MAIN RESULTS

The main result is the application of the ECODESING principles in making the model of the designed product by cost reduction, identification and replacement of materials which are harder to access (by purchasing procedure and cost price) with a material which is usual and cheap. So the “water glass” can replace, due to its properties, the infiltrant Z-Bond 101.

7. OUR RESEARCH IN THE FUTURE

The researches for the use water glass in modeling will continue. Water glass can be used as a binder in creating surfaces (of different finishing and structure) and pieces (by modeling mixtures of fine sawdust and sawdust). These researches allow the use of waste resulting after the wood processing (sawdust, fine sawdust).

8. CONCLUSIONS

Applying the principles of ECODESIGN (Ecodesign, Grant CNCSIS, 2007) in modeling represents research opportunities to take optimal and economical decisions. The use of sodium silicate as a replacement of the hardener recommended by the production company of the 3D printer Zprinter 310 Plus, the infiltrant Z-Bond 101, presents not only financial advantages but also the possibility of easier procurement of the substance. Easier to be purchased and cheap, from cost point of view, the sodium silicate permits making the models at lower costs.

It can be concluded that the experiments which were made permitted the followings to be established: the applying method (immersion, brushing), the optimal percentage of dilution (50%), drying environment (room temperature 18 -20 degrees Celsius), drying time, optimal number of applied layers (in order to allow later the finishing of the model), ways to use the wood waste (sawdust, fine sawdust) by mixing them using water glass as a binder (to obtain surfaces of various granules of the superficial layer, or mould pieces, having different shapes, in order to obtain marks with ornamental value).

The disadvantage in applying water glass on wood or on wooden structures is that the sodium silicate crystals appear (in time, due to the humidity in the atmosphere). (This work was supported by CNCSIS – UEFISCSU, project number PNII – IDEI code1226/2007).

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