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DESIGN OF TEXTURES BASED ON AFFECTIVE ENGINEERING FOR COMPETITIVE DIFFERENTIATION IN WOOD BOARD INDUSTRIAL SECTOR

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ABSTRACT

Preliminary results of FONDECYT No.11130394 research project, funded by National Science and Technology Commission of Chile are presented. Proposal is the methodological model assessment to design textures feasible to be produced by Paneles Arauco S.A. This model integrates affective engineering design techniques in the process, which allow to design products with the best user's acceptance expectations. Study of 112 individuals was carried out to determine emotions they felt or they would like to fell in four living spaces: living room, bedroom, waiting room and transit areas, which results are used to build tables with semantic differential scales. A 3D printer is used for model manufacturing and a CNC machines for prototype's elaboration. Twenty four textures were selected in 500x500x9 mm format and focus group was carried out in 108 people to know correlation level perceived by linking predefined emotions to textures. Statistical analysis was carried out with SPSS 19 and patterns definition for future designs by using qualitative analysis. Effectiveness of integrated design process to define 3D visual textures that increase assertive differentiation by companies is demonstrated.

Keywords: Affective Engineering, textures design, company, plywood

1 INTRODUCTION

Research focused on textures design for wood panels by using methodologies from affective engineering to complement industrial the design process (Prodintec, 2006), predefining emotions with influence on purchase decision (Tiest, 2010). Preliminary project results which hypothesis assumes that experiments with texture designs to create new products by board industry, applying affective engineering techniques, increase chance of assertive differentiation, achieving better approximations to needs and expectations of future users. Affective engineering, defined as discipline responsible for establishing relationship between feelings and emotions that product generates in individuals (Nagamachi, 1995) joins methodological design process using Semantic Differential and Kansei Engineering. Models with visual textures were designed and manufactured based on predefined affective properties using 3D printer and CNC machine (Computer Numerical Control). Both definition of emotions and texture studies were carried out by focus group. Statistical analysis was performed with SPSS 19 and definition of patterns for future designs by using qualitative analysis. Effectiveness of integrated design process is demonstrated to define visual textures.

2. LITERATURE REVIEW

Scientists focused research to study the human beings perception as response to the interest in psychophysics, neuroscience and the creation of computational models (R. H. LaMotte, 1991)(Connor & Johnson, 1992)(Lederman S. J., 2006). Many consuming goods are likely to be seen and touched by individuals, perceived by all senses, so that emotions transmited by products to consumers will inevitably have influence on final decision to buy or reject product (Villanueva, et al., 2013). Manufacturing of commercial products capable to get specific effect on consumers could have great economic impact on product design (Jordan, 2000). Additionally, contemporary look to project in conceptual phase, defines potential of sensorial experience possible to be perceived by themselves through material expression and the meaning they have (Rognoli & Levi, 2005). World perceptual experience occurs from different ways: sensorial, affective and symbolic (Stein, 1993) which would suggest that the experience of using product is different for each individual. However, there are studies proving that some superficial characterizations implemented in consumer objects of different functions, are perceived by users under same or similar valuations. For example, color and material also contribute to experience of heat in scarves and trays (Fenko, 2010) while freshness experience in soft drinks and washing liquid for dishes, will depend more on smell than color. Furthermore, it has been found that sounds removing dust have influence on total quality perceived (Hekkert & Schifferstein, 2007). These results suggest that to create a nice product, designers should pay special attention in properties they will print on materials that will have contact with user. According to Desmet (2008), designers can influence emotions caused by designs. Cognitivist theories state that although emotions depend on several factors, underlying conditions are universal and every different emotion is caused by unique preconditioned pattern, which allows predictions about emotions caused by object (Hekkert & Schifferstein, 2007).

Affective engineering becomes relevant in the design process because it reveals emotional responses of future users, which results in generation of market products with features that allow companies to attract more customers and enable greater user satisfaction, regarding the experience of using product. Affective engineering allows investigative approaches focused on tactile or sight texture perception study and/or usage (R. H. LaMotte, 1991), by incorporating information access methods. Semantic Differential is a definition tool created by Osgoog and colleagues (Osgood, 1957) to assess quantitatively and systematically inherent semantic meaning of concept, while Kansei method is Japanese word (kan: sensation; sei: sensitivity) used to denote object qualities to transmit pleasurable emotions in the usage (Lederman S. J., 2006). According to Norman (2005), "if everything works as it should, fulfilling expectations, affective system will have positive reaction providing pleasure to users. Similarly, if design is elegant, beautiful or perhaps fresh and fun by itself, affective system reacts positively again".

3. MATERIAL AND METHOD

3.1. Semantic differential components assessment

To define Semantic Differential from which drawn textures are designed, it is necessary to know emotions felt by people and those they would like to have in four living spaces: living room, bedroom, waiting and halls. User target more available to new solutions for environment and for emerging or consolidated purchase power, between 20 and 55 years (average 31 years), 48.2% women and 51.8% men. 112 free question surveys were used in written questionnaire format. Sample estimation to implement surveys was carried out based on total surrounding population corresponding to 10,055 individuals.

Information is arranged in database created with IBM SPSS STATISCTIS version 19. Each survey consists of eight separate questions in two groups: question A to find desirable emotions; question B related to emotions. Both questions have a maximum of three alternatives to answer, to raise a total of 2,688 words. Terms referred to emotions are grouped into twenty concepts with higher presence in surveys (Ekman, 1993).

	EMOTION	ASSOCIATION ACCORDING TO EMOTIONAL CONTENT AND FREQUENCY
0	bothering	Tiredness, Indifference, Tedium
1	Homely	Kindness, Welcome, Accompanied, Accompaniment
2	**Distraction**	**Fun, Joy, Entertainment, Recreation**
3	Comfort	**Distension, Resting, Functionality, Reflections**
4	Eagerness	Anxiety, Oppression, traffic jam, Despair, stress, tension, pressure, Concern
5	Harmony	Friendship, Love
6	Disgust	**Disgust, rejection**
7	Attention	Alert, Curiosity, Interest
8	Trust	Refuge, Safety
9	Convenience	Pleased, welfare, Comfort, Warmth, Shelter, Satisfaction
10	**Mistrust**	**Confusion, dissapointment, chaos, disorder, mistrust**
11	**Disagreement**	Tiredness, Dislike, Listlessness, indifference, dissatisfaction, discomfort, frustration
12	Excitement	**Exaltation, Excitement, Happiness, Happy, Joy, Inspiration, Vitality**
13	Worried	Disorientation, restlessness, impatience, insecurity, uncertainty
14	Freedom	Quickness Width, Expedite, Fluency, hurry, Speed
15	Fear	Anger, indignation, wrath, paranoia, Danger, Panic
16	Passion	Desire, Enjoyment, Plenitude
17	Relaxation	**Distension, Laziness, Patience, passiveness, sloth, relax, sleep**
18	Loneliness	Bitterness, Privacy, Silence, Sadness, Emptiness
18	Surprise	Astonishment, Imaginative, Innovative
20	Quietness	Calm, Order, Patience, Peace, Respect, Serenity, Quiet

Table 1 -Twenty Basic concepts. Source: Own elaboration

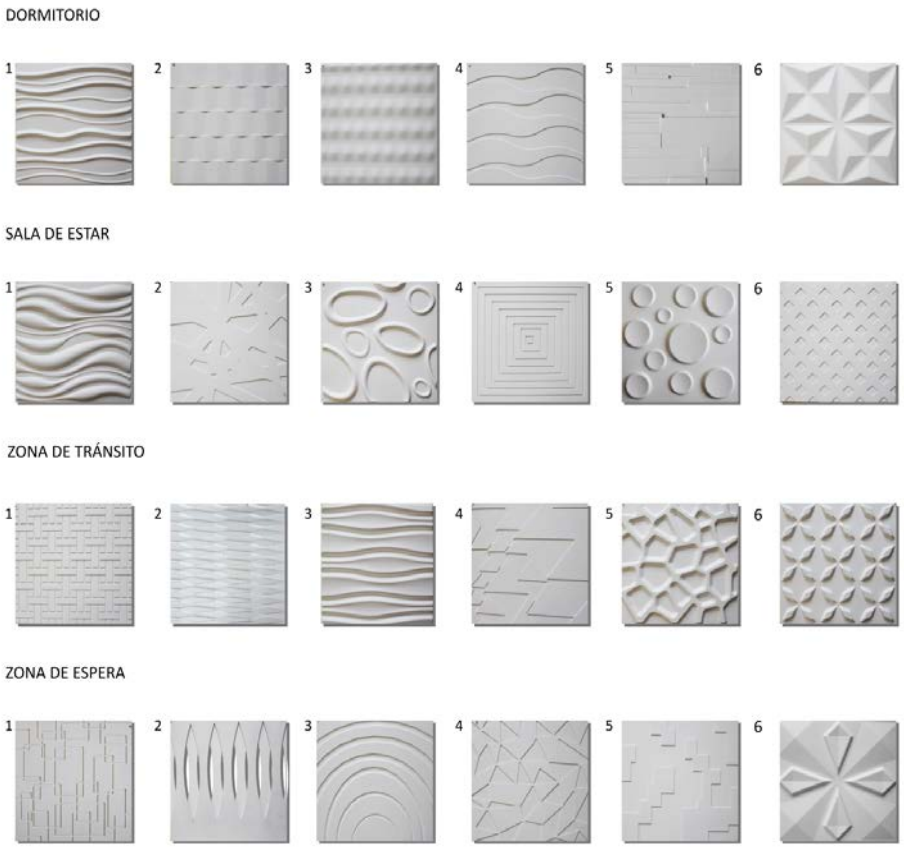
Terms included in first answer of each environmental category of question A are considered. 488 terms associated to emotions, duplicated or otherwise, without loss or excluded terms are completed. To select emotions obtained as part of the implementation of Semantic Differential, number expected of "Chi-square test (x2)" frequency calculated for each space is considered lower limit. All terms over the N expected cut point, are included to prepare tables for surveys to find relation between emotion and texture.

Statistic contrast (Chi Square) represents significance level ≥ 0, indicator that frequencies appeared are not random. Then, the most representative terms, depending on environments established for this study, comprising semantic differential are:

-Bedroom : quietness, comfort, relax.
-Living room : comfort, distraction, quietness, comfortable.
-Transit area : confidence, freedom, quietness, attention.
-Waiting area : quietness, comfort, confidence, distraction.

3.2. CHARACTERIZATION OF TEXTURES

Considering tabulation results, twenty four textures are designed which are subject in focus group to find patterns associated to form and emotion. Models are prepared in 3D Stratasys uPrint SE printer. Prototypes are manufactured in white color HDF 500x500x9 mm boards with CNC technology (Computer Numerical Control). Some of them are made similar to products available in the market, as they respond to types in study.



3.3. Measurement of Affective Response

Semantic Differential method is used to get people perceptions by conducting focus group. Affective meaning -emotional reaction- of individuals in front of textures designed for four environments is required. To define valuation range of emotional experience in relation to texture, second survey is elaborated considering semantic scale previously determined, using emotion and antonym to define range. For example, we can say that questions in this instrument are presented as follows:

Question 1: In Bedroom: Room specifically designed for relax and/or sleep. Facing texture displayed, which of the indicated emotion is better associated with the object if you are located in bedroom?

EMOTION	3	2	1	0	1	2	3	EMOTION
Comfort								Discomfort
Relax								Stress
Quietness								Restlessness

Table 2 -Type of questions for survey 1. Source: Authors.

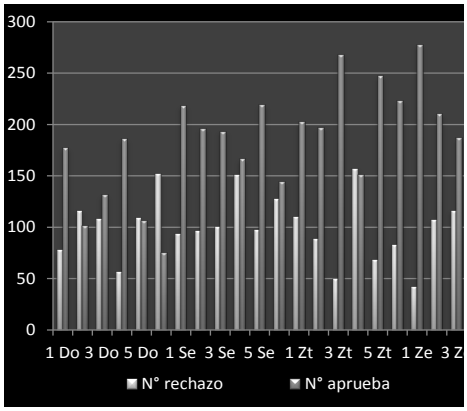
Focus group was conducted in neutral environment, with chairs arranged for fifteen individuals facing textures displayed to be observed for ten seconds, each one untouched. Six types of textures, numbered 1 to 6 are displayed for each space. Once information captured in survey is processed, associations between texture and emotions are known. Statistical analysis was performed with SPSS 19 and definition of patterns for future designs used qualitative analysis.

3.4. Prediction of Affective Properties of Textures

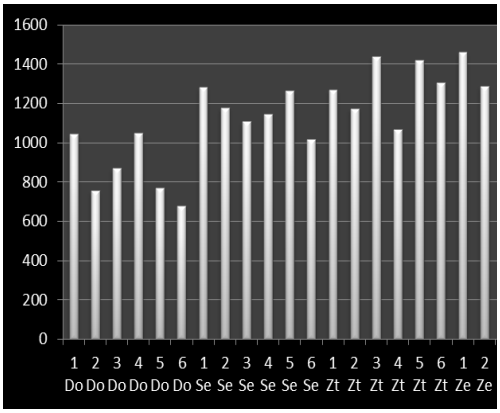
3.4.1 Extraction of Texture Features

Statistical analysis is performed by descriptive and inferential method and matrix mathematical model. The instrument's internal consistency verification and reliability of measurement scales, is based on Cronbach's alpha, with recommended rate from a minimum of 0.7 and 0.8. Descriptive analysis of frequencies is necessary to indicate samples with the highest emotional approval unlike those showing higher rejection.

aphic 1: Aprovals v/s Rejections.



Graphic 2: Total value.



	MODEL N°	N° REJECTIONS	N° APROVALS	TOTAL VALUE	PREFERENCES ORDER
Bedroom	1 Do	78	177	1040	2
	2 Do	116	101	752	5
	3 Do	108	131	866	3
	4 Do	56	186	1049	1
	5 Do	109	106	768	4
	6 Do	152	75	674	6

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Living room	1 Se	93	218	1282	1
	2 Se	96	196	1177	3
	3 Se	100	193	1105	5
	4 Se	151	166	1142	4
	5 Se	97	219	1260	2
	6 Se	127	144	1014	6
Area Transit	1Zt	110	202	1269	4
	2Zt	89	197	1171	5
	3Zt	50	268	1435	1
	4Zt	157	151	1066	6
	5Zt	68	247	1420	2
	6Zt	83	223	1302	3
Waiting area	1Ze	42	277	1459	1
	2Ze	107	210	1286	4
	3Ze	116	187	1126	6
	4Ze	121	209	1301	3
	5Ze	77	253	1426	2
	6Ze	115	175	1134	5

Table 3 -Summary of approval and rejection frequency. Source: Author

In Table 3, bedroom, Model 4DO has the highest acceptance rate with 186 of preferences for emotion, relax, quietness and comfort variables. The lowest rejection rate with 56 options, is among discomfort, tension and restlessness variables. Following in relevance order are 1Do, 3Do, 5DO, 2Do and 6DO tube test.

Living room environment has the best evaluation, test tube Nº1, with 218 approvals, including emotion, comfort, distraction, quietness and homely variables. There are 93 choices for rejection variables: inhspitable, inconvenience, discomfort and uneasiness. Test tubes 5Se, 2Se, 4Se, 3S and 6Se follow in descending approval order.

In Area Transit, test tube No. 3ZT is the best ranked with 268 acceptances for trust, freedom, quietness and attention. There were 50 not approved variables, lack of interest, distrust, oppression and restlessness. Following samples in preference order are 5Zt, 6Zt, 1Zt, 2Zt and 4Zt.

In waiting area, test tube No. 1Ze, has a higher acceptance with 277 approvals for emotions calm, comfort, confidence, distraction, with total of 42 disapproval for discomfort, distrust, boredom and restlessness. Further back are in order of precedence 5Ze, 4Ze, 2Ze, 3Ze and 6Ze test tubes.

Statistical analysis that allows hierarchy, is added to qualitative by using observation and brainstorming methodology, conducted jointly by group of designers to determine patterns for future designs. Both views allow additional assessment.

5 RESULTS

Statistical analysis selects twelve test tubes from a total of twenty-four under study. Review of formal aspects is done in this sample where three test tubes show greater preference for space to establish common standards for new designs.

The maximum rejection rate as specified in frequencies like options that show negative emotions, make easier to consider those textures showing unfavorable expectations to be selected for next stage of research.

Cheking method for internal consistency of instrument and reliability of measurement scales, is based on Cronbach alfa recommended.

Preference ordering indicated for bedroom test tubes (4DO specimens, 4Do, 1Do, 5DO, 2Do, 6DO) which according to total sum of frequency values in the valuation of scale in Table 3, is coincident compared to approval and rejection rates (a / r).

MODEL	TOTAL VALUE	APPROVALS	REJECTIONS	A/R
4Do	1049	186	56	3,32
1Do	1040	177	78	2,27
3Do	866	131	108	1,21

Table 4 -Comparative bedroom model rate. Source: Author.

The order of preference indicated for living room test tubes in Table 1 are: 1Se, 5Se, 2Se, 4Se, 3Se and 6Se), which according to total sum of frequency values in the valuation scale is the same in the three largest sums both in order and value as Table 5.

MODEL	TOTAL VALUE	APPROVALS	REJECTIONS	A/R
1 Se	1282	218	93	2,34
5 Se	1260	219	96	2,26
2 Se	1177	196	96	2,04

Table 5 -Comparative living room model rates. Source: Authors.

The indicated preference sequence order in transit area is 3ZT, 5Zt, 6Zt, 1Zt, 2Zt and 4Zt, as shown in Table 1, and confirmed as index calculation a/r according to Table 6:

MODEL	TOTAL VALUE	APPROVALS	REJECTIONS	A/R
3 Zt	1435	268	50	5,36
5 Zt	1420	247	68	3,63
6 Zt	1302	223	83	2,69

Table 6 -Comparative transit zone model rates .Source: Authors.

The preference order for room waiting area is 1Ze, 5Ze, 4Ze, 2Ze, 3Ze and 6Ze, as shown in Table 1, confirmed as index calculation a / r according to Table 7:

MODEL	TOTAL VALUE	APPROVALS	REJECTIONS	A/R
1 Ze	1459	277	42	6,60
5 Ze	1426	253	77	3,29
4 Ze	1301	209	121	1,73

Table 7 -Comparative waiting room models rate. Source: Authors.

Observations by five designers for four spaces and the first three preferences, in terms of textures are: for bedroom parameters defined are sinuosity, smoothness, uniformity, repetition playing with light and shadow, depth, continuity is defined; for living, parameters are asymmetric, dynamic, variable patterns, volumes pronounced by light and shadow; transit zone is characterized by predictable direction suggested hues, circulation, reliable, slow, continuous present but sparse; and waiting area defines irregular geometry, movement, dynamism, constant depth with a tendency to plane rectilinear lines

6 DISCUSSION

In our daily life, textures are continuously present in many market products and, therefore, extensive studies to establish emotions of people when they perceive texture, are interesting from a scientific and commercial perspectives. As for technologies used in the process of ideation, it may be mentioned that 3D printers, for available research model, allow 200x200x3 mm testing tubes. This technology is suitable for testing small-scale textures. For this study, the use of CNC technology used is suitable for 500x500x9 mm. testing tubes manufacture up to size 1200x2000 mm.

It is found that methodology used is efficient in terms of logistics to collect emotions of people. Results are useful to design process since they constitute a guide for designers and input for definition of new textures using parameters provided by statistical analysis and consensus ratings from observations. Method under experiment to look for building methodological model can be improved, but it firstly provides consistent results, as evidenced by the low percentage of rejected textures. Tools used are adequate to predict emotions, since correlations among responses of participants and emotions used lead to the definition of useful parameters to be incorporated in the ideation phase of new proposals.

6 CONCLUSIONS

We have known emotions of 112 individuals and other they would like to feel in four living spaces: living room, bedroom, waiting and transit zone, which results are used for Semantic Differential scale tables. 3D printer is used for testing tubes manufacturing and CNC machines for prototyping. Twenty four textures in 500x500x9 mm format are selected and focus group takes over 108 people to know correlation level observed in relation to predefined emotions. Statistical analysis was performed with SPSS 19 and patterns definition for future designs using qualitative analysis. Effectiveness of integrated design process to define 3D visual textures that increase assertove differentiation by companies is demonstrated. Findings on how textures can be linked to desirable emotions to these spaces are observed. Moreover, the same information led experts and/or intuitively select textures associated to predefined emotions (kansei). The research allowed in this second stage to study the correlation between emotion and texture, showing that methods, the use of light and shadow, lines reliefs and various

expressions, are capable of printing feelings based on predefined emotions. The ability to perceive through sight becomes relevant to the extent that it is the first connection source to enter in space, it alows to perceive distance and recognize qualities of our surroundings without touching. On this subjet, method determined to design first textures is suitable, since rejection rates tend to 0. From the twenty four textures designed and subject to survey, twelve were selected, three corresponding to each space. Method used for statistical analysis and for construction of design patterns, worked fully to define parameters of new texture designs. Data collection is optimal, as well as tools and analysis methods, however, further studies will provide the necessary information so these steps can become constitutive of a design methodology that integrates emotional engineering in process design.

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