The Process of Providing Integrated Design Solution for Child's Psychological Reluctance by Multiplication of Matrices

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ABSTRACT

Having problems with child's healthy nutrition has significant physical and psychological effects, both in childhood and throughout life. In this study, which results from master degree thesis of Industrial Design, in order to clarify the methodology of industrial design in designing interactions as well as psychological infrastructure of interaction with the child, it has been intended to develop concepts of trends in the field of child design elements and the child's desire by addressing independent variables determined from the phenomenon. Since emphasis was placed on the psychological dimension of mentioned problem, in this study, the interactions of influential variables in child acceptance of healthy nutrition were examined by means of Causal Layered Analysis (CLA) technique. Then, after recognizing the psychological ergonomic factors, a suitable methodology for child design was presented. In the problem identification phase, independent variables of problem of not being feed 3 to 6 years old children by healthy nutrition (assumed there is sufficient and easy access to resources) were shown. In order to identify the variables related to the problem, in-depth study of keyword-related fields was conducted among previous scientific sources, standards and researches. Also, in order to qualitatively evaluate the phenomenon as a human social experience, valid questionnaires of children's eating habits and behavior were reviewed and the questions were rewritten under the supervision of industrial design and child psychology experts. Then they were distributed in the form of an open questionnaire with interview support to parents and the answers related to each variable were categorized separately. Then, in order to investigate the extent and manner of effect of dependent and independent variables in creation of the problem, placement of variables in graph space with the matrix vector multiplying act was used. Finally, in order to perform Meaning Driven Design as possible as comprehensive and integrated solution, related parameters in each phase were placed into matrix, and the final trend was defined as an overview diagram. The results of this study showed that the main reason for lack of acceptance of healthy nutrition is in any way, not complying with sensory parameters of aesthetics and psychological ergonomics of child. Also, this issue can be re-studied from the perspective of user experience after studying and determining the integrated design method of those parameters along with training nutritional behavior in the form of controlled feeding process.

Keywords: Health design, Design methodology, Psychological ergonomics, and Meaning Driven Design.

INTRODUCTION:

The most influential period of human life is childhood, and from any point of the view that interaction with the child is happened, if it is not in accordance with his scientific and the cultural principles, a problem will be created and will lead to his/ her deviation from healthy

state. This issue has been proofed times and times both from physical (Barton and Josiane Cobert, 2011) and also from psychological growth aspects (Kelishadi R & Movahedi A, 2015; Biswash *et al*., 2022).

Actually child not eating the food is a common much involved problem during childhood disorders. These problems happens during first years of life and include behaviors which make nutrition process hard, not only to child but to parent. And finally it can make negative footprints for individuals influencing to their adulthood both personal & social. According to the wide amplitude of researches and also to increasingly tending concerns to the child's development, and also to daily growing tender to technology and the rapid change of lifestyle paradigms, especially in developing societies, the need for sustainable development is being perceived as well as a forward-looking attitude in design of child-related devices, services and systems, both at aesthetic and interactive levels, and at more underlying levels. Thus futuristic strategy in designing products and systems related to child is being felt more and more, in aesthetics and interactional layers.

Today, a kind of lifestyle is being experienced which one of the undisputed consequences of that is tendency of adults ,as a result, to spending less attention, time, patience to the children. Researches has shown that a child's inappropriate eating behaviors and a stressful parent-child relationship cause eating problems. Parental stress increases a child's misbehavior and Child misbehavior, in turn, leads to increased parental stress (Mosaheb P & Zeinali S, 2011). As one of the index variables, it was identified in a study that nutrition education and counseling is effective in improving nutritional behavior and choosing the right diet. However, in this study, an improvement in the nutritional status of individuals was observed, but there is a long way to go to reach the desired nutritional status, by means of long-term and continuous follow-up of individuals (Faravarde and Anboohi, 2023).

Therefore, in the present study, the main goal is to investigate how to solve the problem of child acceptance of healthy behaviors specially nutritional one which leads to improper tasting and tendency to consume low-value industrial sweets and snacks, and to study a suitable way to design an optimal solution to

encourage and increase the educability of child and his/her parent during a long-term usage process and to provide behavioral stability in them. The problem of not accepting home-cooked food by child, except those of before three (which in those ages also, they need to repair a lot of infrastructure before birth and during infancy), mostly focuses on the knowledge and skills of child caregivers. To do this, it is the necessary that while designing a product or the service for children, before starting, phenomenological research monitor and the analyze the phenomena, situations and events around the child's life for all variables of the desirability of solution for both children and adults. The main challenge of this study is to provide a research to choose a coherent and comprehensive approach for the problem of generally child welcoming to healthy lifestyle, and specifically, healthy eating behavior with considering to the identify problem dimensions for the second user, the parent. For this purpose, first the variables led to absence of food was omitted and examining other factors that shape this problem as a phenomenon was investigated, Including social factors, dietary patterns before the age of the three. Current parental behaviors as well as environmental constraints and variables, which cause mental and emotional states in children, & finally as a result, forming their decision to eat or not to eat healthy food. The conversion of qualitative to quantitative and measureable variables in foods was also investigated shortly as well as try to understanding effect of parents' reaction about eating avoidance by children, on the formation of problems in the phenomenon of child nutrition.

METHODOLOGY:

Firstly studying the literature and research of its predecessors, specially addressed to mothers of the children from 3 to 7 years old in Tehran By random stratified sampling with adequate access to food was conducted. After, Questionnaire questions of variables found from library research As well as valid questionnaires used in the research of the predecessors (Including Nutrition Screening Questionnaire, Carner and the Garfinkels Nutrition Attitude Test) (Rivas, T. & Bersabe R. 2013; Kelly Patlan & the others, 2022) and CEBQ and CFPQ Children Eating Behavior Questionnaire (Munoz, A & others, 2021; Metcalfe, J. & Fiese, B, H, 2016), Planned Behavior Theory (Ajzen I, 2006) & Questionnaire

for Exclusive Breastfeeding, Food Satisfaction Questionnaire (James, B.L and others, 2018), Social Demographic Factors (socio-demographic factors and the parameters which define the socio-psychological aspects of parent-child relationship) and Eating Habits Questionnaire (Lanfer, A & others, 2011) by observing the principles of compiling a qualitative questionnaire was gained.

Topics studied in this article include cognitive and psychological ergonomics, child aesthetics and interactive design trends, which in all these titles, determinant parameters are considered as variables with the possibility of correlation and then they interact with each other in a matrix. (Nykamp DQ, "Multiplying matrices and vectors" From *Math Insight*). It is necessary to mention that by definition, the variables identified in each phase are examined in parallel, & concepts obtained at the end of each section are considered as the next phase variables, led to conclusions.

Research phases

The phases of the design process were the organized according to the child nutrition problem identification strategy as follows:

1) Writing the current situation scenario &layering the causes, and identifying the problem and problem variables, & areas of research related to the child,

2) Research in scientific sources and field research to find the optimal confine of variables, in resources related to the principles, standards and culture and identifying the values of the target community, including the child, parents, care-givers and child specialists, as well as child market values,

3) Examining the matrix of the variables and finding design attributes, by matching the values of the target community with the three "principles standard-culture" items & finding solution features.

These features are defined by matching the obtained attributes with the solution values and defining a design approach tailored to the child and child-related adult experiences. Ideation of the general solution format, application of innovation techniques & principles of the "aesthetics and ergonomics" for systematic architecture and solution desirability architecture; According to performance indicators.

DISCUSSION:

Scenario review, layer by layer review of causes, and problem identification and problem variables and domains

To begin identifying the problem, it is necessary to carefully record the observed topic and identify the events that are related to the topic. In this project, the nutritional status of the child was observed and written in the following situations: "Breakfast at the home", "Lunch in the kindergarten", "Afternoon outside the house" and "Dinner at home."According to the method of "Casual Layered Analysis (CLA) ", the process of finding cause and analysis of an event, before being considered as a problem, starts from the level of the expressions or Litany level **Fig. 1** (Scupelli, P. 2022).

Here the issue of child nutrition was raised and the phenomenon of the child eating (especially at home and when the child is exposed to home food) was analyzed. By observing and paying attention to this event, it was found that the child's expressions towards home nutrition often include negative expressions, which indicates the existence of a problem in the subject area. According to the "Litany Surfaces" diagram, the process of identifying the dimensions of the problem began by observing its most obvious surface, and then the beliefs of the user's mind (which led to negative expressions) were examined. And in the more infrastructural layer, the system level or the information related to the physical and cognitive dimensions and the needs of healthy nutrition (which were not observed in various aspects and caused problems) were examined. Finally, the child's world-view on what and why of these principles were identified. After observing the user's expressions in the face of his/her reactions to external stimulators, we turn to his/her beliefs (which led to their objection). Problem-building stimulators can be divided here into aesthetic stimulators as well as behavioral and environmental stimulators. In fact, they can be mentioned as parameters to be researched. It is noteworthy that the investigating the litany level is done by registering the current situation. Therefore in here it is paid to registration of observations as current situation scenarios (that led to the formation of that event). After that, it will be analyzed for each event and the key factors that caused the formation of that particular event will be determined.
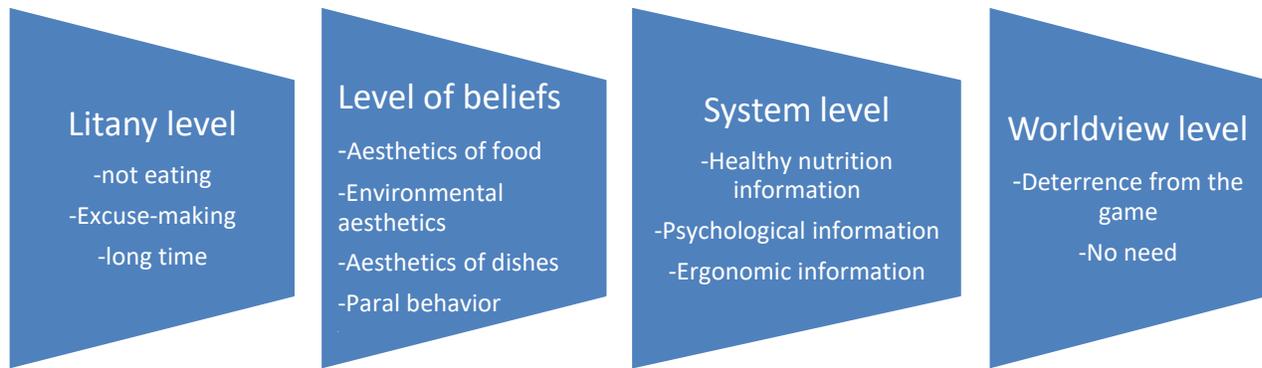
Litany level
-not eating
-Excuse-making
-long time

Level of beliefs
-Aesthetics of food
-Environmental aesthetics
-Aesthetics of dishes
-Paral behavior

System level
-Healthy nutrition information
-Psychological information
-Ergonomic information

Worldview level
-Deterrence from the game
-No need

Fig. 1: Litany level categorizing.

These factors are considered unstabilized if they are accessible and intervened by a force within the limits of the designer's authority, and if they are outside the desired limits - such as legal laws or organizational requirements - they are conside-red stabilized. Because the unstabilized key factors are caused by non-confor-mity with one of the principles or cultures related to the subject, they are considered as defects that have been created under the influence of a driving force. Therefore, by the identifying the driving forces as vari-ables, after summarizing all the observed events, those events can be measured, evaluated and the managed (**Table 1**).

Table 1: The process of extracting problem variables from the phenomenon.

Driving force variables	Driving Forces Inconsistent)	Unstable key factors (Problem)	Event	Phenomenon

Identify areas related to the problem
Then, in separate tables, the key factors of the phenomenon under study are summarized, and then the variables of the driving force (as long as they do not enter each other's domains) are summarized (**Table 1**) . After this stage, in order to identify the areas related to the problem, the classification of these variables is done and based on the Abundance of variables and the effectiveness of each of them in creating the problem, these categories will be prioritized and weighted (**Fig. 1**). This means specifying what areas and by who much proportion the response process to that the phe-nomenon should be aware of be from each. In general, this stage induces a sense of response to the designer to be able to create the appropriate mental space to build the desired scenario. To know the frequency of vari-ables at first glance, it is enough to add their number together. However, a category, despite being less frequent, may have variables with a higher impact rate (in creating a problem). Therefore, in order to know the depth of influence of each variable, it is necessary to observe the general phenomenon and reactions of the target community and after the event, to interview

users, to understand the depth of involvement of each variable in the phenomenon. Therefore, for each vari-able, a range of influences (based on the Likert scale) can be considered from very favorable to very unfavor-able (from 1 to 5). And then the number obtained for each variable by the number of variables in each category should be multiplied to determine the exact weight of each category. Of course, it should be noted here that interpretation of the interview should be done by experts in related fields. This is because in some cases, the interviewees' responses may differ from the main actual emotion factor; and the other underlying reasons may have led to their reaction (**Table 2**).

Classification of propulsion force variables
Prioritize the impact of propulsion forces (based on the number of interventions in Unstable Key factors, to understand the response approach) (**Fig. 2**)
1)   Planning (10 items)
2)   Personal characteristics of the child (6 items)
3)   Food and tools (5 items)
4)   Information (food, training) (4 items)
5)   Skills (3 items)

Table 2: Summary of key factors of eating resistance phenomenon.

| Driving force variables (non-compliant)	Key factor (problem)	Event
Aesthetics of food taste and texture - Volume - Memory and cognitive information - Entertainment (functional attractiveness) - Maternal cultural belief - Food pattern (schedule) - Ergonomics and Aesthetics and Anthropometry of tools - Desirability of food tools	Lack of motivation to eat	**Resistance to eating**
Diet pattern - Fatigue - Environmental ergonomics - Number and arrangement of equipment - Degree of table and chair freedom - Fatigue of parents - Interest in discovery and intuition - Safe attachment - Traffic	Child boredom	
Mother's educational method - Behavior regularity - Mother's duties and thoughts (singularity) - Coordination with the father - Mother's behavioral creativity - Declaration of independence - Individual and social skills	Mistreatment from mother	
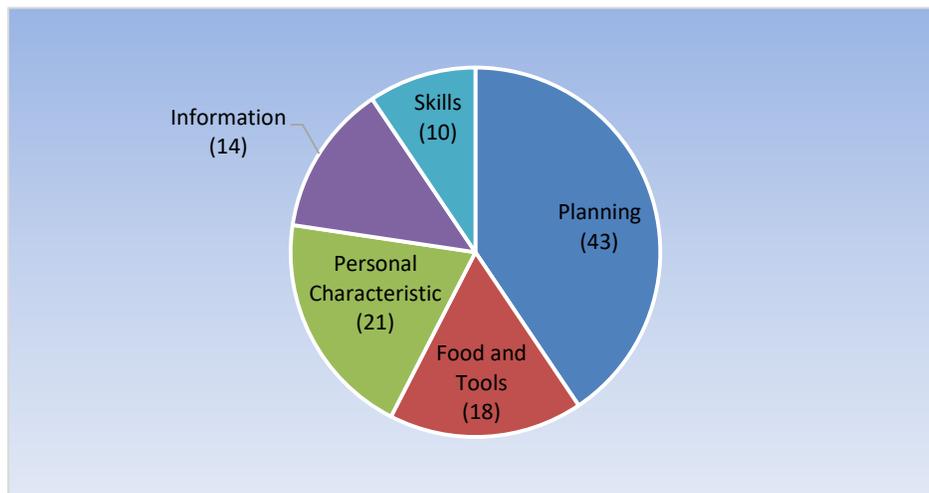
Fig. 2: Prioritize the impact of propulsion forces.

A Comparative Study of the Driving Forces with Trilogy of "Principles, Standards and Culture (Regional and International)"

After identifying the Driving forces and their variables, it is necessary to identify the optimal limit of each variable as well as the boundaries of the overlap of these limits. To identify the optimal limit of each variable, this is done by referring to scientific sources and standards. To do this, research questions are the developed. This means that each of the identified variables is questioned separately, and for each question, the main purpose is identified, and related keywords are searched to find areas related to the questions.

The process of this research was done in the following areas as standards:

1) Ergonomics, ergonomics and anthropometry for children, types of systems, usability, feel & color, aesthetics in food & tools and environment, toy design

2) Food system and culture, the local and traditional foods, appetite and eating habits

3) Program, diet and eating habits, nutrition, healthy and unhealthy foods, food basket

4) Education, knowledge, food education, consumer behavior, nutritional behavior, behavioral psychology, experience

5) Sensory acceptance and processing

6) Child psychology, development, learning, skills, games, symbols and signs

7) Control and monitoring, criteria, growth assessment

8) Relationship, parent-child relationship & effects, nutritional relationship, parent-related relationship factors

In addition, to research in scientific sources, research was conducted on the subject of the "child" and "child nutrition" to use their results to make the findings more realistic and the up-to-date. This stage also led to the

identification of valid research methods and question-naires corresponding to them, and to be used in the conducting the question and interview phase of this research.

Studying the matrix of variables and finding the Attributes and the characteristics according to the principles of industrial design:

In this study, CFPQ, FFQ, CEBQ and "General House-hold Information" questionnaires were identified and after combining traceable factors in a the questionnaire obtained from the previous researches, with traceable factors obtained from the keywords of the previous section, a qualitative questionnaire was prepared to the assess the quality of specific variables (from parents of children), which was answered by 20 parents, and after categorizing the information, the mothers' responses and the examples they cited, each of the following were extracted in order to mentioning their frequency as the domains which attributes will be found in them from matching their standards with driven forces:

1) BMI and growth information;
2) Favorites;
3) Eating methods and dealing with malnutrition;
4) Playing;
5) Imagination;
6) Diet plan;
7) Child involvement in preparation;
8) Parents' ideas

In addition, the interviews were conducted with child psychologists and child nutrition specialists and the professors of industrial design who are active in field of children for study more on the standard's domains. The research went through these levels: Introduction, Follow-up factors in the questionnaire resulting from key words, Follow-up factors in the questionnaire re-sulting from the research of the predecessors, question-naire, key items Implementation, Data analysis (deve-lopment data and BMI, food interests, Eating methods and facing malnutrition, the playing-yes or no, imagin-ation, Diet planning, Child involvement in preparation, Parenting ideas). Development of design theories and presentation of practical materials: After the imple-mentation of the questionnaire and the collection and analysis of information and tacit knowledge from the children's parents, as well as by observing and talking

with the children about the eating, a more detailed examination of the information of chapter 2 related to the results obtained from the questionnaires & obser-vations was done (Ergonomics, Culture, indigenous culture and the traditional foods, Nutrition and diet-Nutrition and food allergy in the children's health, diet planning, Children's promises, Dietary energy, The desired food basket of Iranians, the Food pattern of low income people, the Nutrition and the poverty line, Foodstuffs, Healthy Foodstuffs, Nutritional Value, Un-healthy Foodstuffs, food habitation, Recommendations to modify eating habits & behaviors, Taste develop-ment in children, Child growth & the developmental stages, Cognitive development, the Child Psychology, Individual characteristics of the child, Child's mood, behavior, Exploration strategies, Helpful behavioral tips, untidy, disobey, the Self Confidence, Creativity, Attention deficit hyper-activity disorder (ADHD)., Growth monitoring, Growth measurement indicators, Growth monitoring card, Regular growth monitoring program, Individual skill, Education, Dietary know-ledge, Dietary education, Food behavior training, Ap-propriate dietary behavior recommendations, nutri-tional security, becoming a role model, Child states and suggested reactions, Behavioral strategies, How to promote healthy behaviors, Implicit teaching of child behavior).

After determining the quality of the variables, it be-came apparent that each key factor might be supported by several variables (driving force), and therefore for each variable one should refer to the standard or the related principles. However, in some cases, it may be observed that the maximum optimality of one variable causes a decrease in the quality of another variable. Here, after determining the standard amount of the variables independently, to find the optimal point in each intersection, it is necessary to first intersecting points are identified by the process of matrix making from variables (**Table 3**), and as far as maintaining and increasing the desirability and pleasure of child, their attendance in solution is to be decided.

Key Factor X 1   Key Factor X2   M, N=driving force $(M_1,M_2,\ldots,M_i)$ x $(N_1,N_2,\ldots,N_j)=$

Table 3: Matrix making from variables.

	M_1	M_2	…	M_i
N_1	N_1M_1	N_1M_2		N_1M_i
N_2	N_2M_1	N_2M_2		N_2M_i
…			…	
N_j	N_jM_1	N_jM_2		N_jM_i

In this project, three key factors: food & environment, child, and parent behavior were identified .Thus, three matrices are obtained by matching these three factors. The result of this conclusion is a maximum (but integrated) package of variables that make up the phenomenon under study. By considering them in different situation and times used by the user, the corresponding key factors can be improved and a favorable scenario of that phenomenon can be imagined.

Dependence of user experience on space and time
It should be noted that in addition to considering the interactions of the variables of the propulsive forces, on the other hand, it should be born in mind that a problem may be affected by different variables of each of them in different places and times, so they may appear in different ways. For example, the problem of children not eating may be caused by a group of driving forces inside the house, while in other environments (due to the intervention of new variables or the removal of some variables in the house) it has different intensity and weakness. So to provide a progressive and sustainable solution, and also because it needs to improve the user's internal variables to increase his/her self-awareness & independence from the environment, there is a need to embed symbols in the final solution, which show their presence in different situations, albeit in different ways. In other words, a solution needs to be both condition-independent and from another point of view condition-dependent. However, given that the set of features of the solution (whether signal or the functional), they must eventually find a coherent and integrated form, to produce a unified concept in the user's memory, they need to be flexible in different situations, but still realize the main goal. This means that they are inherently more influential than environmental factors; both in terms of the reactions it gives to environmental factors, and also in terms of intrinsic concepts, which affect the user's core emotions. Especially in the particular case of the child, whose

judgment of objects is more & sooner than influenced by the utilitarian achievements of the products, it is influenced by the feelings and emotions caused by the encountering its phenomenal and tangible aspects.

Impact of the design approach from the concept of essence and personality of the product
The purpose of studying this part is the methodology of integration of attributes in the final solution. Interactive design is a type of user-centric design, which is always looking for easier ways to connect industrial products with users (Khodadadeh, Y & Yaqubian, S., 2007). Since the aim of this project is to establish a stable relationship between the end answer and the child (main user) with the aim of motivational design, According to the definition of interactive design and the psychological foundations of the child, the desired aesthetic elements of the child can be used in designing the concept. In fact, the attempt is made to the achieve the correct knowledge of a positive thing or healthy nutrition by the creating desirability. As the character of the industrial design relates more to the concept of cognition than to the concept of knowledge, or, in fact, industrial design involves more cognition than knowledge (Heidegger M., 1935). On the other hand, for the success of the design response in the child market, it should also be noted that, the answer must be supported by a different concept than other concepts of the products around the child and the parent. Also from a branding perspective, in markets where products and services are becoming more and more compatible, a strong brand may be the only characteristic that distinguishes a product or service from competitors (Rafiee *et al.,* 2012). Green argues that an ideal satisfaction of ownership and use stems from a strong combination of action and emotion (Green, 1999). So here, in order to achieve the Upper Right point in the design utility diagram, the functional identity of a product, as well as its signs and symptoms, must be in a way that is consistent with the child's aesthetics, That is, the child's mental acquired visualizations and perceptions and cognition, about that object awaken in the mind (Nedayifard, 2007).

Concept preparation
Therefore, according to the discussion presented in the product personality section, to define a concept that should be inspired to the user by a set of selected

features, again we refer to the user needs and product goals to extract these concepts (Ulrich *et al.,* 2020). Another point that gets a lot of attention about product attributes is that although these features are very large, if we want to categorize them according to the main design functions, they often fall into two categories: functional and sensory. This attribute shows that the idealism identity of any product depends, above all, on human nature and best performance it means they two should be present in the product; in such a way to satisfy humankind needs and serve him, and also to stand for morality and nature for his welfare. The aesthetics of the product must also be in line with these principles (physical and mental health of the child). Since the concept used in the answer must support a logic appropriate to the user (here the child), first we need to shortly define the logic. It should be noted that logic is a way of thinking, under which not just new programmed technologies work but also is useful for understanding and utilization of human. Therefore, it seems to create more child enjoyment of products and systems, and at the same time, in order not to drown him in the context of technology, bringing him closer to the use of logical thinking (and not just the use of technological elements) will cause the child to ride on his environment. This is a key point to keep in mind when designing.

Fundamentals of Aesthetics

Scientific articles have proven that stimuli such as light, color, music and rhythm, have an effect on the stimulating the human sensory states, and how users perceive, and on their sensory quality (Khodadadeh, Y and Yaqubian, S., 2007). Regarding the relationship between appearance features and performance and aesthetics of the product, the place of aesthetics in the design should be considered. According to Alexander von Baumgarten, beauty can be interpreted from three perspectives

 1) Aesthetics from the point of view of the general concept of beauty
 2) Aesthetics from perspective of philosophy of art
 3) Aesthetics from the point of view of cognition and sensory experience

Adult's judge from beauty places in the first category, and children judge of beauty (especially in relation to the product) places in the third category (i.e., cognition and sensory experience). Because of the their limited information and experimental memory, children may not be able to understand the nature of the product's features and personality at first glance and they need to experience them directly as they cannot also find the affordance of objects because they have no memory of what a product offers them (Gunnar Eidsvik Tvedt).

Optimal condition

After reviewing the basics of design desirability and the concept to be applied, in order to clarify what is desirable, the key factors and the corresponding driving forces must be the redefined and return to the standard state. This process is entitled "Explaining the Stability of Key Factors "and by considering the three columns "event", "stabilized key factor", the "driving forces", it is adjusted as in the previous table, but with improved variables. Therefore, according to the identification of the phenomenon in the ideal state (intended by the designer), which is also based on general and local principles and standards, and the factors of nobility of the solution in the eyes of the child are included in it, it is now possible to describe the desired situation in the form of desirable situation scenarios. In this project, this step was done in the form of three scenarios and made the characteristics of the general response appear, by drawing from those scenarios and in the form of a general instruction. According to the collected practical information, which is the result of three principles:

 1) Exploring the results of questionnaires and
 2) Gaining an overview of the current situation, and the characteristics of the target group, through observation and interview with the samples

And 3- by examining the direct principles & standards that were discovered after the identification of general areas. Now we will answer the research questions accurately by the mentioning their examples. These answers, in fact, express the characteristics that the desired solution must have in order to achieve the goals of the research.

Recognized social value

Social values are divided into three general categories: the"Agnosticistic", "Environmentalistic", & "Individualistic" and according to the knowledge gained from the

child study during library and field research, these values are expressed as follows (**Table 4**).

Table 4: Social Values categorizing.

Individualistic	Environmentalistic	Agnostic
Active, to satisfy needs, secular, rapid satisfaction of needs, materialism, hard work	Cleanliness, positional, transformational, securitistic, formalism, naturalism	Individual, youth, unlimited family belonging, femininity, competition, difference and distinction

These subsets are considered for the application of valuable cultural factors of the user in the design process. Therefore, after specifying the type of each, it is necessary to write an explanation for each, so that they clearly show themselves when are used.

Attribute extraction

Attribute extraction for the proposed solution means that, in order to the answer the identified problem questions (Driven forces), and in the process of the evaluating the hypothesized suggestions (hypotheses) as designers, we seek to select and use principles that are consistent with the users "identified social values ". Therefore, the process of this interaction and extraction of Attribute is determined as the following matrix: (**Fig. 3**)

Attribute extraction example

(Driven force): The importance of having a body mass index (BMI)

Principle

Do not worry if your child is at a suitable height and weight. If he eats one or two bites, it is not a problem.

Social value

Strength; the mother's awareness of the child's growth status (height according to weight).

Attribute index

The possibility of continuous measurement and storage of height and weight and growth monitoring and providing a growth monitoring card (communication with health centers)

M_{st} = Matrix of Principles, M_{sv} = Matrix of social values, M_a = Attribute index matrix

M_{st} x M_{sv} = M_a

$$\begin{bmatrix} a_{st1} \\ a_{st2} \\ ... \end{bmatrix} \times \begin{bmatrix} SV_1 & SV_2 & ... & SV_j \end{bmatrix} = \begin{bmatrix} a_{st1}\,SV_1 & a_{st1}\,SV_2 & ... & a_{st1}\,SV_j \\ a_{st2}\,SV_1 & a_{st2}\,SV_2 & ... & a_{st2}\,SV_2 \\ ... & & & ... \end{bmatrix}$$

Fig. 3: Multiplication of Principles and Social value.

Each of the asti SVj parameters obtained may (if they have a conceptual commonality) represent a component called an attribute index. An indicator that can guide the designer to what and how of the attributes which are applied. Given that, by definition, product attributes are in fact characteristics of the product by which the product is known and famous. Therefore, according to the common values of the target group and general and regional principles and standards, in this study the Attributes requested by the user that can be implemented in product were obtained as follows:

Informative, believing, shaping, planning, flexibility, personalizing, involvement, role-playing, imagination, sensing and intelligent behavior.

Attribute objectifying

In fact, this stage means the ways of implementing the attributes, by the theories, techniques and facilities known from the research process of designer which are proportionate to his creativity. For example, in this study, response attributes were defined as follows (**Table 5**).

Table 5: Attribute objectifying.

Implementer (of Attribute)	Attribute Criterion
choice theory, correct conditioning, to being role model	Informative
Creating value in eating practice, modifying parental behavior patterns, modifying child health beliefs,	Belief building
Turning a child's painting into an edible role, molding foods, transparency of the production process	Shaping
Creating planning role in mother's behavior, planning to eating habits	Scheduling
Create a comprehensive profile at startup , creating free spaces in the app for proportional interaction	Flexibility, personalizing
Pouring materials, opening and closing doors and arms, talking, asking a parent, commitment the mother to be with the child and pay attention	Interference, role-playing
Show interactional cartoons, encourage painting realism, encourage food-centered imagination in conversation, being alive,	Imagination
Receive audio and video, and processing information and compliance with principles, Recording and analysis, Suggest food and behaviors	Intelligent measurement and behavior
Happy music at the beginning, during and end, flashing light for each section, Demonstrative arm movements, excitement in the cartoon, being new in every time of use	Fun and exciting
Shell with integrated form and simple design, performance explanation, blinking the intended section of use, preparation speed,	Simplicity of form and ease of use

Feature extraction
To operate Attributes
In the following, after extracting the attributes that were matched with each of Keegan's values (which represent the general indicators of the value of a pro- duct or service), According to the explanation written about each attribute, its corresponding Kegan value is also determined and as a result, indices are extracted as feature (**Table 6**). In fact, features refer to "specific possibilities of a technology to operationalize features:

Table 6: Feature Extraction.

Feature indices	Kegan values	Attribute
*Automatic weighing of the child * Analysis and drawing of the growth curve * Safety and health warning	Technology driven (On time appearance)	**Measurement and intelligent behavioure** The possibility of continuous measurement and storage of height and weight and growth monitoring and providing a growth the monitoring card (connection with health centers) BMI intelligent control

Adopt an approach
On the other hand, According to the content mentioned in the product personality section, To find out the how and the general format of the solution And in order to know which attributes should be put together in what order, in order to be liked in line with the intended goals and personality of the product, Knowing the design approach for the proper induction of the con- cept through the identified attributes should be done.

At the stage of adopting the design approach and specifying the focus areas of the solution design and using the principles defined for that approach, the intensity of the user's experiences is investigated in three axes where the goods or services are supposed to be defined in some amount of each of them To match the experiences identified by the user (child) **Fig. 4**.

Diagram of layers of experience
According to the examination of the indicators of the different industrial design approaches, it is clear that each of them has something in common with the res- earch topic. This means that for some issues, it is not possible to refer to only one approach for answering. Especially in the case of the child and its relationship with various parameters such as nutrition, parents, peers, physical and mental developmental issues, and gender issues (that each of the which has a different atmosphere) this issue is felt more.
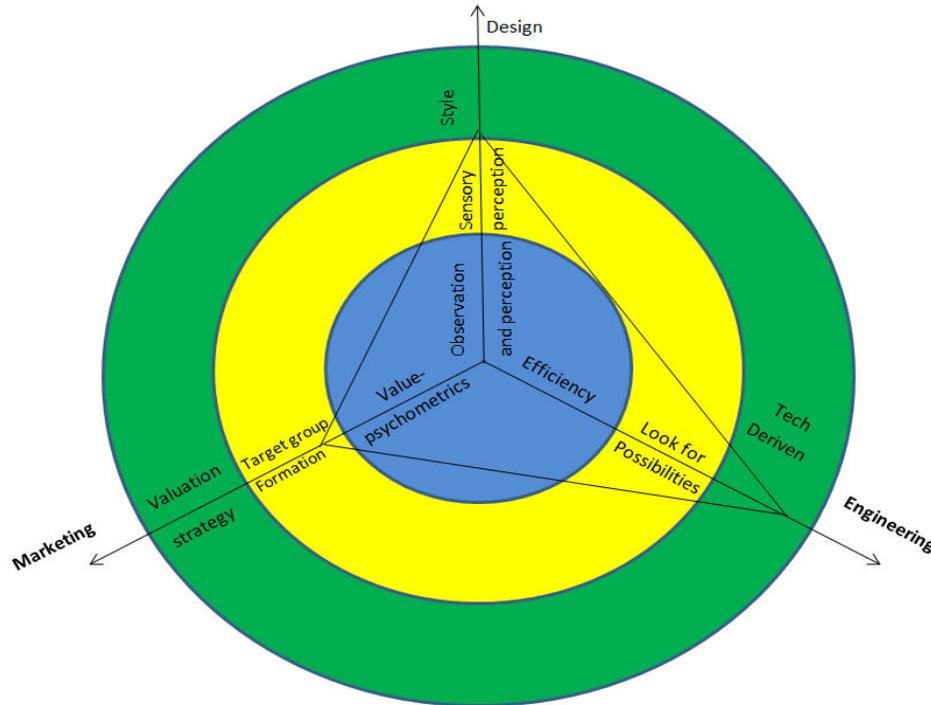
Fig. 4: Diagram of layers of experience.

But what makes a phenomenon valuable to a child most of all, is Providing the possibility of his/her interaction and involvement in that phenomenon. Because the know-ledge of the child in the growing age is due to his/her great desire to experience the phenomena of the world around his/her and remember the positive and negative emotions caused by them to the judge similar cases later. For this reason, according to the definition, child-centered interactive design with an emotional approach is what was most sought after in this project. Although maintaining the principles of sustainable design to keep a healthy experience in the child's mind, they were also taken into consideration.

The process of converting attributes into features
Now that the examples of the concepts have been determined, to implement them into the solution from the aspect of the obtained attributes, the process of converting attributes into features is discussed. Since

for each attribute, special tools or theories have been proposed in the process of objectifying attributes under the title of implementation, here, the specific suggestion for each feature should be addressed. This process requires a search among the facilities available in the market as well as a search among the features of the products related to the user (**Table 5**). But at the same time, according to the principles of interactive aesthetics, it should be determined which sense of the user should interact with which feature in order to create which emotion. Here, after specifying all the possible features for use, analyzing the interaction between the selected features and the child's five senses is done by **Table 8**. (In this table, the numbers are expressed as symbol of the attribute implementations, which are supposed to be obtained from the interaction of the attribute column and the five senses row. For example (**Table 7**).

Table 7: Symbol of attribute implementations.

Accountability and Decision Making: Choice Theory	1
Correct conditioning: the phenomenal and functional attractiveness of health, reward food	2
Modeling Parents and Friends: Referring to parents, connecting with friends	3
Creating value in the act of eating: a cartoon character, recording a pleasant taste	4
Modifying Parental Behavior: Recognizing and Showing Behavioral Tips	5

Table 8: Interaction between features and the child's senses.

Taste	Smell	Touch	Hearing	vision	Senses Feature
			1،2،3،4،5،14،15،16،20،23،24،25،28،34		Speaker
			1،20،21،22،25،26،34		Mic
				1،2،4،15،30،34	Monitor
				3،4	Modem
				2،25،34	Eye
				14،25،34	Arm
21،34		21،34	1،18	16،32،34	Food maker
				16،17،29،32	LED ....

Conception and product architecture

Here, in a sense, all the parts of the answer are the specified and it is enough to define a body for this organ, which is achieved through Conception. For example, the features stated in **Table 6** can be assembled and designed in the form of products. Such as: food bike; a plate with a monitor; a doll that feeds a child; device...

Description of features, product components & operational groups. After determining what is meant by the adding each feature and what kind of interaction is intended, in order to create a more realistic picture of the ideas that emerged in the mind, we went to search the market for the parts mentioned in **Table 6**. And those pieces that match the aesthetics as well as the definition of psychometric-economy (equivalent value of money spent) are registered.

However, the designer should not limit herself to the products available in the market, because at just this point, facilities may be designed that are not available in the market, but best meet the designer's desired concept. And the need to invent it and mention it in the production planning of the overall product. Such as a specific type of monitor or the use of a new type of technology in the final product or service. This work (whether using existing parts or inventing a part or a new technology or both) requires a description of the features, an example of which is mentioned below:

1) Reaction to the child's behavior: the microphone and the camera continuously record the child's voice so that if a voice louder than the permissible limit is recorded, or a sudden and out-of-bounds behavior is recorded on the camera, or an interruption in eating is recorded on the camera, the device will take action. Do two activities at the same time. 1- Talk to the child and calm him/her down by the starting a favorite song or a short cartoon. 2- Show the appropriate reaction recommendation on the back monitor for the parent to take the necessary action.

2) Registration of growing up information

3) Chapter 2 information about standards is uploaded in the product application in the form of an algorithmic tree and...

Classification of product components

Product components are divided into three categories in terms of their physical nature: electronic, virtual, and mechanical

Systematic design

After choosing a specific form of product or service (in this project, due to the lack of dedicated food processor products for children, a food maker was selected). The processes that are supposed to interact with each other, with the environment and with the primary and the secondary users in order to produce the desired concepts should be systematically designed. Therefore, after classifying them in terms of being electronic, mechanical or virtual, we define the operating systems that are supposed to produce a specific service or product. (Operating systems) and then they are the grouped under the title of "building groups". In this project, two functional and intelligent groups were defined (to guide the interaction of operational groups) and for each, the component diagram was determined by drawing their relationship.

Building groups

Also, to express the type of operation that each component should undertake in the product، the specific operation of each feature is discussed. For example, a group of components have the task of the intelligent operation, which should be separated according to their function:

1) Received: record and process information,
2) Transmittal: interactive, informative

Functional Diagrams

In order to specify the equipment that is supposed to be placed in the product to perform a specific process, it is necessary to first specify the necessary components for each function. For this purpose, the diagrams of the product components are prepared in the following order: First, the general operation diagram of the device is drawn; then diagram of the electronic components and mechanical and intelligent operation diagram will be drawn.

By drawing the component diagram in a specific and general way, a static picture of what is going to be used in the product is obtained. This step gives a good view of all the equipment that is going to come together in a general format. After that, in order to determine the process of product operation and its phenomenal and functional details, the dynamic diagram of different parts is drawn. Here, one of parts of device is the mentioned.

Dynamic diagram of Salad maker (**Fig. 5**)

1) Choosing menu in monitor
2) Child's voice command and pressing button.
3) Microphone
4) recognition
5) mini computer
6) The function of the bobbin and the opening of the spring-loaded bladed door of the salad maker, turning on the LED.
7) Voice command "Fill the salad maker" by speaker.
8) Pouring salad ingredients by the child
9) Press and close the bladed door and lock the compartment by the user.
10) Sensor signal to the mini computer.
11) Commanding the bobbin and opening the lock again, the sound of the "salad is ready" from the speaker. Turning off the LED by the command of the mini computer.

12) Removing the dish by the child.
13) Pouring the salad on the plate
14) A very important point after this part is determining the scope of the user's interaction with the system, along with the mentioning the active elements of the user and the answer that is the supposed to be given to his at each stage. This diagram helps the designer to more accurately and objectively consider the work steps and the aesthetic effects of those steps.

Placement of components of building groups

The placement of components should be considered from two points of the view. One is technical and physical safety, and the other is ergonomic and the aesthetic (The Design of Everyday Things; Donald A. Norman) which will bring the production of desirability, ease of use and usefulness.

Sensitivity matrix

Considering the work interference and the effects that the inputs and outputs of each building group may have on the components of other groups, it is necessary to know the relationship between the components and the type of the interaction between them, the distance of the system components to each other and the musts and The limitations of their placement in the overall body of the product should be determined. Also, due to the presence of the user as one of the influential elements in facing each input, it is possible to accurately understand the role and depth of their placement in the product, and their availability and visibility in the product (**Table 9**).

Due to the proximity of different parts to each other, it is necessary to grade the necessity or destructiveness of their working interactions in relation to each other, so that these considerations are also taken into account while arranging them together at the end, by specifying what the components are and how they interact and interfere with each other and also with the user (or primary and secondary users), with the precise determination of the name, dimensions, price, and how to prepare and assemble (DFM) for each feature under the stage of choosing physical features, the pre-design stage of the product is completed by sketching the proposed designs and the design of the selected design.
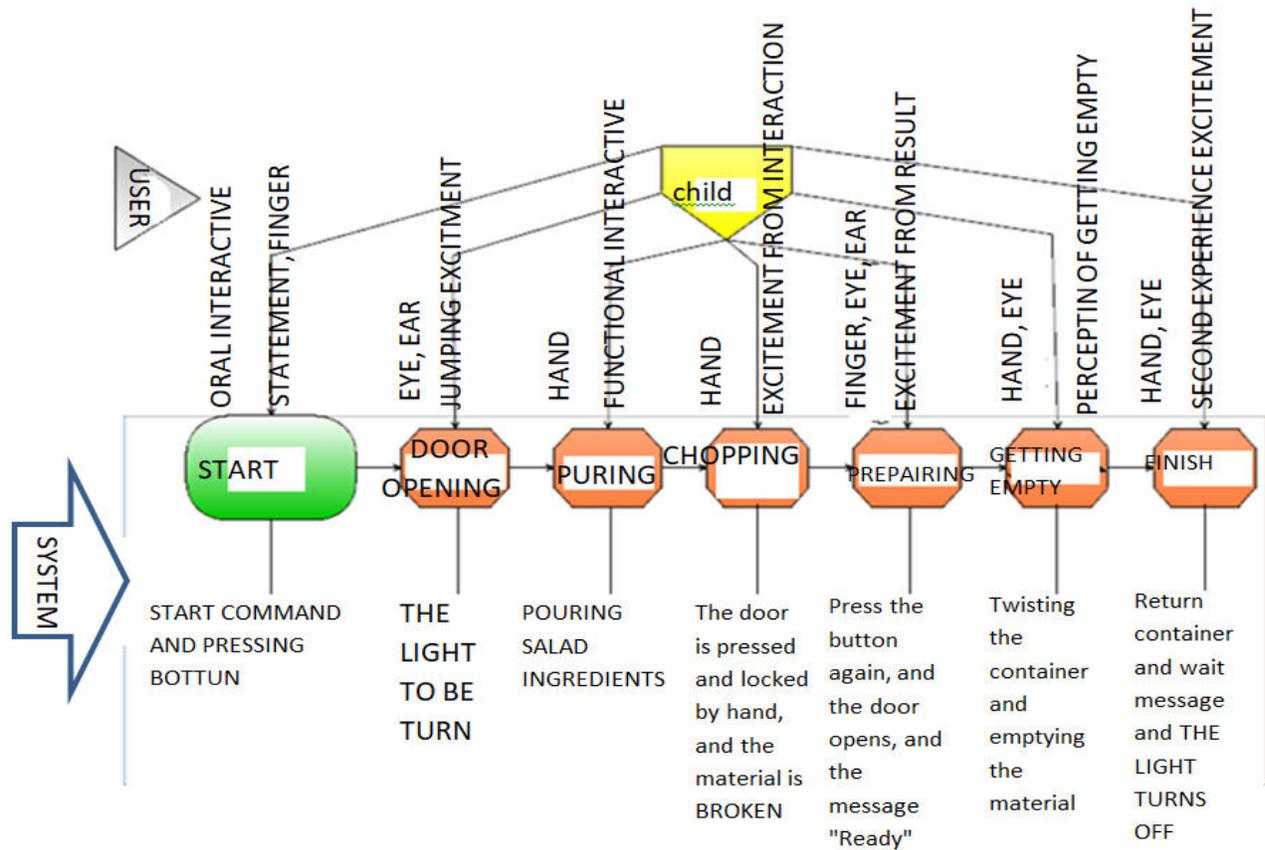
Fig. 5: Dynamic diagram of Salad maker.

Table 9: Sensitivity matrix.

Impressibles / Triggers	Electric boards	Bobbins	Wires	Monitor pack	Eyes	12v power supply	Speaker and microphone	Camera	Air pump	Hoses	Servos	Printer mechanism	Joints	LED Tapes	Child's happiness
Juice liquids	4	4	2	3	3	4	4	4	3	1	4	3	3	2	viewing the process
Fruit pieces	4	4	3	2	2	3	3	3	2	2	2	2	2	2	pouring
Sauce and dough	4	4	2	3	3	4	3	3	3	1	3	3	3	2	making
Snack	3	3	3	2	2	2	2	2	2	2	2	2	2	2	putting
Egg	4	4	2	3	3	4	4	3	3	2	3	3	3	2	pouring
Mince Meat	4	4	2	2	3	3	3	2	2	1	2	3	3	2	pouring
Soup	4	4	2	2	3	4	4	4	3	2	3	4	3	2	stirring
Cooked rice	4	4	2	2	2	2	2	2	2	2	2	3	3	2	placement
Blade rotation	4	4	4	4	4	3	4	4	3	4	3	3	4	4	view the process
Matrix blade	2	4	4	2	2	2	3	3	2	4	3	3	2	4	push
The heat of the tray and the lid of the snack maker	4	4	4	4	3	3	4	4	3	4	3	3	2	4	dangerous
Pressure, and hand strike	3	3	4	3	4	2	3	3	2	3	3	4	3	2	desirable

1= intransitive, 2= safe, 3= Gradual failure, 4= immediate danger

Due to the proximity of different parts to each other, it is necessary to grade the necessity or destructiveness of their working interactions in relation to each other, so that these considerations are also taken into account while arranging them together at the end, by specifying what the components are and how they interact and interfere with each other and also with the user (or primary and secondary users), with the precise determination of the name, dimensions, price, and how to prepare and assemble (DFM) for each feature under The stage of choosing physical features, the pre-design stage of the product is completed by sketching the proposed designs and the design of the selected design.

Design brief

1- Function: how to work with the device after taking the product out of the package, 2- Environment: placement environment, safety issues such as placing it in safe places or overturning liquids 3- Product service life: For children 4 to 7 years old. But the life of the device is 5 years or more. 4- Repairs and maintenance: The possibility of replacing parts such as the monitor in case of failure or body and fittings broken, also a capability of a notebook to be attached, and also in the user menu, Type of packaging for shipping, Market entry strategy: advertising: television, environmental and internet advertising, Circulation: total production circulation: first year, distribution location, first three years, circulation calculation: the number per month, the Materials ready parts. Target cost, selling price: production facilities and assembly equipment Quality and reliability: increasing the reliability of the product, (FMEA), the dysfunctions - functional quality - failure report or request to modify the values In this Part the general track of project will be cleared which has started from discovering the problem as subject, to the end of track by means of stating an overview report. The report sections are specified as Feasibility Study and is divided as below:

1- Need analyzing. 2- Design. 3- The Material. 4- Packaging (signs, arrangement in box …). 5- distribution (the distribution channels from the material store, sale place, the critical points, material charts, Design philosophy & Design thinking). 6- conclusion: Design description with concept statement. 7- Designer suggestion for investment (F.S. and costs & prices of the manufacturing (planning for manufacturing), distribution (planning for distribution), use (Planning for use) and retirement (planning for retirement)

Pre F.S. (Need assessment and the necessity of the problem)

During the process of the needs identification and evaluation of SET factors the project went through the items were being sold in Metro. It discovered that the best seller product category was belonged to immediate edible which were most purchased by parents. It shows that they wanted to resolve the problem by rapidly eliminate it by buying snacks. Although there is not few families their poor economic situation leads malnutrition of children, but this problem repeats also through rich families. In childhood, there are two periods of physical development, one from birth to 2 years old, and the other from 2 years old to puberty, and also one of the psychological development period of childhood is in 3 to 7 years old. Therefore it's obvious that the period 3 to 7 is one of the most important in developmental years of children.

Feasibility Study

Hereby, the main keyword and characteristics of the feasibility study are stated as bellow:

1) The social and human type and characteristics of customers: Target groups: Direct user: the child-indirect, the indirect user: mother, Kindergarten nurse, 30 to 40 years old.
2) Culture (religious beliefs, consumer culture, and customs)
3) Investigating the financial situation of the target community
4) Demographic changes
5) Product and consumer related statistics:
6) IRAN population, internet and mobile utilization statistics, playing in home, Playing thematic interest, Culture (religious beliefs, consumer culture, customs), minimum physical growing up, a higher nature than meeting basic needs, Investigating the financial situation of the target community, The selected target group (upper middle class), consumer market, Demographic changes, The increasing birth rate of children in the 80s.

Matket studies

Increasing rate of jobs related to children ،can be seen from the establishment of kindergartens as well as toy and stationery stores and child psychology institutes, etc. Thus the market were also reviewed as bellow

Market trends

Market structure (Traditional and shop, internet shops), Market size (potential and actual) and growth rate (Lack of concentration of producers, Similar products in terms of design theme, origin of markets goods, The amount of formal and functional diversity), Competitors review: (target sentence: Studying, researching, collecting information and comparing signs of positive or negative effect and influence of two or more factors caused by the ingredients, or packaging, or products that make edibles by the children aged 3 to 7 years, looking at the aspects of sensation seeking and They are used for pleasure and entertainment. (To produce a child-oriented product)), similar product production statistics review, Market segmentation and regulations, Export and import customs regulations and tariffs, Toy market in the region, Concept design,

Design requirements (came up from needs)

1- Child involvement 2- Using the child's own interest, 3- Combining eating with the entertainment process 4- Giving the child the right to the choose 5- Sharing 6- Informing parents, 7- Monitoring growth,

Evaluation of design opportunities, selected design opportunity

Features requested by the user (expansion of product attributes): Pre-titles, selected title, software and hardware description of the design. Imposing in the mind, mental image, mental space like a cloud (which induce a sense of softness and freshness to the mind) with the aim of introducing nutrients to the child, implementing manually or through an intermediary, energy from a source other than the body such as electricity or Heat-generating materials or from the user's own hands.

The input part, the process part and the output part, signs, process program, the transferring the controlled force of the user's hand to the device to enter information and commands. Analysis of the similar products in the market (famous brands, advantages, disadvantages, POPs, sunrise factor, sunset factor)

Choosing an interactive approach as a theme

The overall project, the main approach and applied technique for this phase of the project (INDP), is the semantic (meaning Driven design) approach and the FAD technique, also features of femininity, sustainable design, and emotional approach have been used.

Product design to upgrade as much as possible

To ensure long-term use, the update report, periodic services, product design for multi-purpose use, "psychological, monitoring, feeding, training and recall and information analysis" functions.

Realize and understand the simple principles of functions

Consuming resources despite compliance with the functions by reducing structural parts. Simplifying the use of the device for the child, the smartness of the device, product design for adjustment and compatibility during use, Wear and tear, least complexity and least cost, unforeseen and possibly excessive physical forces.

Implementing a consumer-centric product, with the goal of increasing Reproducibility

Environment, efficient use of resources, eco-design

Product design for easy contact

Practicality, type and repetition of use, easy contact with the product, design of interactive parts in order to eliminate complications and maximum guidance for the child to start and continue working with different parts of the product.

Product design for maximum compatibility with different user

Minimizing the space required for product storage when not in use (Saving space with a pleasant and non-redundant image). Minimizing the time needed to the prepare and continue using the product consumables before, during and after use.

CONCLUSION:

It is obvious that when we are talking about meaning driven design first of all we are considering the user-child in this project as an existence that the realize meanings, and in terms of the industrial design this meanings are come out from a product or service. Thus first of all regardless of what is the subject, we should get information about what kinds of meaning the child

can understand and utilize and manipulate with. If not considering this part, whoever we investigate the problem or assumptions or research questions, it won't get correct and applicable result. Because of this, semantics of child which in this project we go through it by discovering attributes and social values was investigated truly to get us to the right solution. In this regard, not just it is shown that meaning driven design can be successive as an approach to create a value for children because the children are very talented to discover the pure meaning from different part as a solution by considering the emotions they receive, but also when we focus on children as our direct user, we should make our solution for him/her as much as confident so that make him/her strong enough to effect on the parents to set their behavior and beliefs along with him/ her needs and attributes. As observed in the present research, the desirable traits in the user's opinion to encourage him to eat healthy, most of all include the planning of meals, and then the necessary skills for eating, tools and food itself, and the food information. Therefore, taking into account that these cases came out from the children themselves or the people involved with them, it is concluded that if the child's desired meanings are implemented in the framework of the these attributes or, in better words, equated, the matter of welcoming healthy eating and Positive eating behavior is also met.

Provided that these values generate inner meanings for the child, so that he/she can directly implement the activity of eating and be able to the achieve both inner achievement and make him/her parents understand him/her needs. Therefore, according to the theory of "choice theory" whose original name was the control theory, it is suggested in any problem to discover the attributes that produce meaning in the child's mind and help him to know himself and his needs better. And as a result, he will gain better self-mastery and control, for each solution, two-way psychology-design research should be done to help the child as much as possible to play a role in his problem. And by seeing positive meanings, his/her character will be the formed with positive meanings, and in this way, he/she can be the encouraged to have positive behaviors and welcome the right materials and goods, increase his/her self-confidence and achieve a higher product success.

CONFLICTS OF INTEREST:

Authors do not have any conflict of interest.

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