

# **Shaping Emotions: An Emotive Form Design Framework for Emotional Disconnect Identification and Creativity Enhancement**

*Thesis submitted in partial fulfillment for the  
requirements for the degree of*

**Doctor of Philosophy**

**in**

**Design**

*by*

**Gaurav Vinod Vaidya**

(Roll No. 186105003)

*Under the Supervision of*

**Dr. Pratul Ch Kalita**



Department Of Design  
Indian Institute of Technology Guwahati  
Guwahati – 781039, INDIA

May, 2023



Department of Design  
Indian Institute of Technology Guwahati  
Guwahati, Assam – 781 039, India

## Declaration

I hereby declare that the work contained in this thesis entitled “**Shaping Emotions: An Emotive Form Design Framework for Emotional Disconnect Identification and Creativity Enhancement**” is my work and done under the guidance of Dr. Pratul Ch Kalita, Associate Professor at the Department of Design, Indian Institute of Technology Guwahati, Assam, India. To the best of my knowledge, it contains no materials previously published or written by another person or substantial properties of the material which has been accepted for the award of any other degree or diploma at Indian Institute of Technology Guwahati or any other educational institution, except where due acknowledgment is made in the thesis. Any contribution made to this research by others, with whom I have worked at Indian Institute of Technology Guwahati or elsewhere, explicitly acknowledge in the thesis. I declare that the intellectual content of this thesis represents my work and words. I have adequately cited and referred to the original work where others’ ideas, work, and words have been included. I also declare that I have adhered to all principals of academic honesty and integrity and not misrepresented or fabricated or falsified any idea/ data/ fact/ source in my submission.

Place : Guwahati

Date : 02.05.2023

.....  
**Gaurav Vinod Vaidya**

(Roll No: **186105003**)



Department of Design  
Indian Institute of Technology Guwahati  
Guwahati, Assam – 781 039, India

## Certificate

This is to certify that the work contained in this thesis titled “**Shaping Emotions: An Emotive Form Design Framework for Emotional Disconnect Identification and Creativity Enhancement**” submitted by Mr. Gaurav Vinod Vaidya to the Indian Institute of Technology Guwahati for the award of the degree of Doctor of Philosophy has been carried out under my supervision. This work has not been submitted elsewhere for the award of any other degree or diploma.

*Pratul Kalita*

02/05/2023

Place : Guwahati

Date : 02 May 2023

.....  
**Dr. Pratul Ch Kalita**

Associate Professor

Department of Design

Indian Institute of Technology Guwahati

Guwahati, Assam – 781 039, India

## Acknowledgment

First and foremost, I would like to convey my gratitude to the Department of Design, Indian Institute of Technology Guwahati for providing the opportunity and facilities to pursue my PhD research. I would like to express my sincere gratitude to my supervisor, Dr. Pratul Ch Kalita for his patience, motivation and immense support towards my PhD research and Thesis. His guidance and encouragement throughout the journey of my research are deeply acknowledged. This work would not have been possible without his timely guidance and excellent mentorship.

I would like to express my sincere gratitude to my Doctoral Committee Chairman Prof. Amarendra Kumar Das, Doctoral Committee Members Dr. Abhishek Shrivastava, and Dr. Deepak Sharma, who have been guiding and giving me meaningful insights and valuable feedback since the beginning to the end of my Research Work. My earnest thanks to Prof. Sougata Karmakar, Head of the department, Department of Design for his administrative cooperation.

I convey my gratitude to Dr. Sandhya Khond, for providing me with the necessary information required for my Research. I am incredibly thankful to Dr. M. G. Sayyad for his valuable feedback and information.

Special thanks to the participants, who are also my colleagues at IIT Guwahati for their contribution and their voluntary participation in my experiments. My sincere gratitude to Asst. Prof. Supardip Das for his guidance and support during the progress of the research. I am forever grateful to the non-teaching staffs of the department for their continuous help and support towards me whenever required.

Last but not the least, I am forever grateful to my friends who have helped me directly or indirectly in completing my thesis, and I would like to convey my special thanks to my family members, my mother Dr. Shubhangi Vaidya for her encouragement and support always and my wife Mrs. Vaishnavi Vaidya for walking by my side throughout this journey. I would like to convey my special thanks to my brother Mr. Tushar Vaidya and my sister-in-law Mrs. Prachi Vaidya for their inspiration. Their unconditional support and encouragement will always be appreciated.



Gaurav Vinod Vaidya

## Abstract

The prime inspiration of this research is to formulate a framework for emotional disconnect identification and creativity enhancement during the product form ideation phase of the design process. The effort has been experimented and successfully demonstrated with a case of form ideation of Bluetooth Speakers.

Today consumers expect more from a product than mere fulfillment of the intended function for which the product is designed. Modern-day consumers demand products that match and satisfy their preferences. Contemporary trends in design show consumer inclination towards objects which motivate them, improve their quality of life and spark emotions. Consequently, along with the functionality requirements, a product needs to serve consumers' emotional needs, and for that, the product must relate with them at their emotional level. The product's visual appearance is responsible for engendering first impressions and initiating a connection at the emotional level before product purchase. Previous research suggests that the emotional element of design could be more crucial in deciding the success of the product than the functional aspect as it affects consumer's decision-making in choosing a product. Therefore, design directed by emotional content is gaining more and more importance in current design practices, research, and education. Thus, designers must possess the necessary knowledge and skills to deal with this design paradigm of product emotions, analyzing the relationship between emotion, consumer behavior, and product design. Moreover, designers should know whether their intended emotions are conveyed to the consumers. These issues were addressed in the current research with a systematic approach in a phase-wise manner.

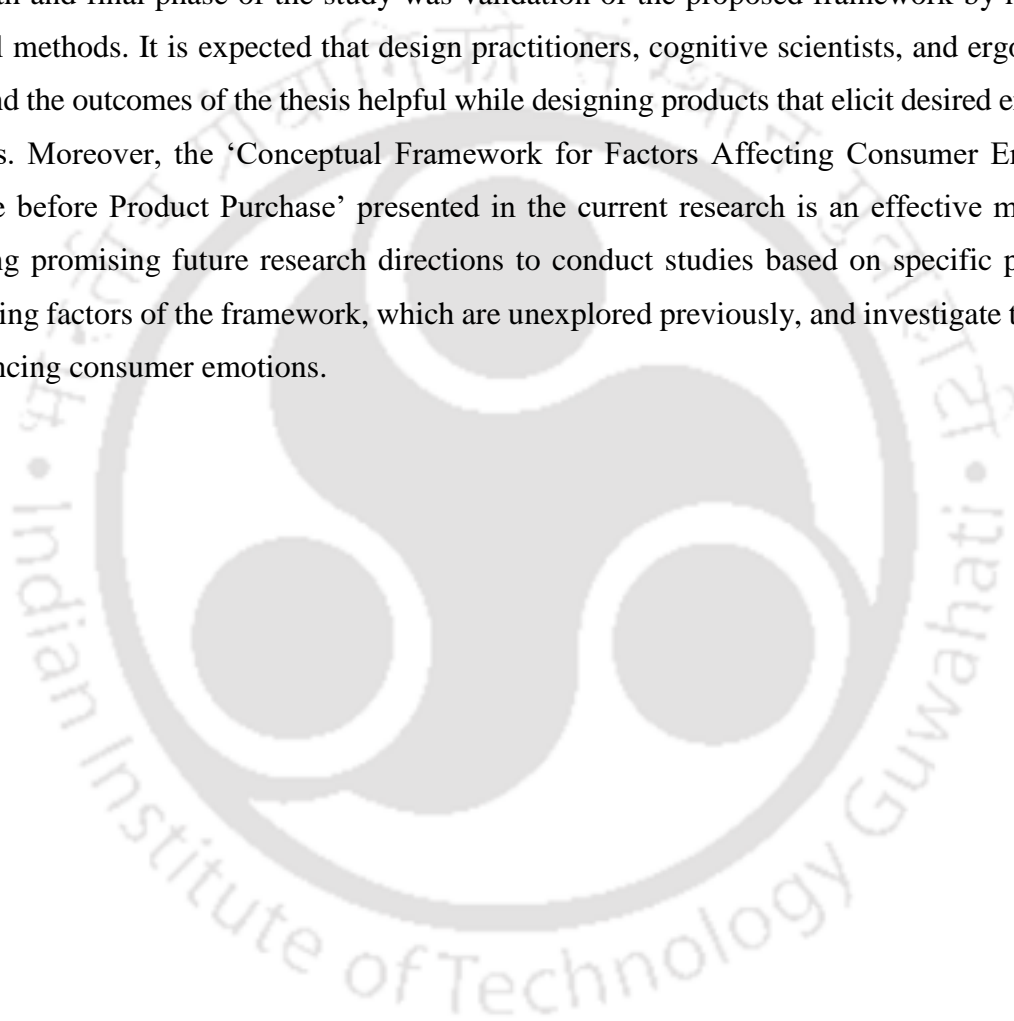
In the first phase, an integrative review of the available literature was carried out. The four major categories that emerged through the analysis of the literature were 1. The Terminology used in Emotion Research, 2. Consumer Emotions and their relation with the other factors such as fundamental product design elements, product judgment criteria, consumer behavior, and environmental factors in the 'before product purchase' scenario, 3. Theories of Product Emotion, and 4. Assessment of Emotion. A multi-faceted evaluation of articles of the first two categories resulted in proposing a new theoretical framework investigating consumer emotional response before product purchase context. The review of articles associated with the fourth category resulted in proposing a taxonomy of the emotion assessment methods and developing criteria for comparing these methods for choosing a suitable one for the product design research context.

In the second phase, a part of the conceptual framework proposed in the previous phase was analysed further. This analysis revealed that no method/tool/framework existed in the current literature that can assist the designer in determining if the designer's intended product emotions

and the consumers' emotional response overlap. A newly developed framework for 'Research Opportunity Identification' was found to be handy in organizing our thoughts and setting our initial research intent in this phase.

The third phase was associated with building 'Shaping Emotions Framework' to assist designers in emotive form generation and facilitate comprehending consumer emotional response on the generated forms. A set of experiments were also planned at the end of the third phase to validate the proposed framework.

The fourth and final phase of the study was validation of the proposed framework by means of statistical methods. It is expected that design practitioners, cognitive scientists, and ergonomists would find the outcomes of the thesis helpful while designing products that elicit desired emotional responses. Moreover, the 'Conceptual Framework for Factors Affecting Consumer Emotional Response before Product Purchase' presented in the current research is an effective means for suggesting promising future research directions to conduct studies based on specific parts and contributing factors of the framework, which are unexplored previously, and investigate their role in influencing consumer emotions.



## Table of Contents

Declaration .....	i
Certificate .....	ii
Acknowledgment.....	iii
Abstract .....	iv
Table of Contents.....	vi
List of Figures .....	ix
List of Tables.....	xii
Chapter 1. Understanding Emotions and their Role in the Design of Products .....	1
1.1 Introduction .....	1
1.2 Literature Review on the Product Design and Consumer Emotions .....	1
1.3 Analysis of Literature .....	4
1.3.1 Terms used in Emotion Research .....	4
1.3.2 Factors Affecting Consumer Emotional Response in the ‘Before Product Purchase’ Scenario .....	5
1.4 Conceptual Framework .....	10
1.5 Opportunity Investigation in the Proposed Framework.....	14
1.5.1 Research Gap 1.....	15
1.6 Development of Research opportunity Identification Framework .....	16
1.6.1 Formation of an Interdisciplinary Team and Team Roles.....	17
1.6.2 The Process of Research Opportunity Identification .....	18
1.7 Research Gaps .....	24
1.8 Research Questions .....	24
1.9 Aim and Objectives .....	24
1.10 Framework of the Thesis .....	26
1.10.1 Brief of Chapters .....	26
Chapter 2. Experiencing, Expressing, and Measuring Emotions.....	28
2.1 Introduction .....	28
2.2 The Phenomenon of Experiencing and Expressing Emotion .....	28
2.3 Theories of Product Emotion.....	29
2.3.1 Emotional Design .....	30
2.3.2 Appraisal Theory .....	31
2.3.3 Pleasure Model .....	31
2.3.4 Technology as Experience Framework.....	32
2.3.5 Product Personality Assignment .....	33
2.3.6 Benefits and Drawbacks of Five Theories of Product Emotion.....	33
2.4 Measuring Emotion .....	34
2.5 Self-Report Methods.....	37
2.5.1 Verbal Self-report .....	37
2.5.2 Pictorial Self-report .....	40

2.5.3	Sensorial Self-Report.....	42
2.5.4	Recall Self-Report .....	44
2.6	Physiological Methods .....	45
2.6.1	Electroencephalography (EEG).....	45
2.6.2	Electrocardiography (ECG).....	45
2.6.3	Electromyogram (EMG).....	46
2.6.4	Galvanic Skin Response (GSR).....	46
2.6.5	Respiration Pattern (RSP).....	46
2.6.6	Speech Recognition (SR) .....	47
2.7	Taxonomy of the EAMs in Product Design.....	47
2.8	Criteria for Selecting a Suitable EAM.....	48
2.9	Ceativity and Assessment of Creativity.....	51
2.9.1	Creativity .....	51
2.9.2	Definitions of Creativity .....	51
2.10	Creativity Assessment .....	53
2.10.1	Conducting CAT .....	53
2.10.2	Selection of Experts.....	53
2.10.3	Number of Experts .....	54
2.10.4	Method of Presentation.....	54
2.10.5	Rating Factors.....	54
2.10.6	Rating Scale.....	55
2.11	Discussion and Findings.....	55
Chapter 3.	Shaping Emotions Framework .....	57
3.1	Introduction .....	57
3.2	Shaping Emotions Framework .....	57
3.2.1	Development of Ideation Support Tool .....	58
3.2.2	Several Seminal Idea Generation Techniques with their advantages and limitations	63
3.2.3	Proposed Emotive Form Design Tool using the Principle of Design-by-Analogy .....	69
3.3	Design for Interest.....	74
3.4	Discussion and Findings.....	76
Chapter 4.	Validation of the Proposed Framework .....	77
4.1	Introduction .....	77
4.2	Planning of Experiments .....	77
4.3	Choice of Test Product .....	78
4.4	Hypotheses .....	80
4.5	Experiment Design.....	82
4.5.1	Sampling and demographics.....	82
4.6	Hypothesis Testing .....	84
4.6.1	Testing of Working Hypotheses.....	84

4.7	Product-Consumer Interaction Scenarios Prior to the Product Purchase.....	89
4.8	Creativity and Idea Generation Ability.....	92
4.9	Discussion and Findings.....	95
Chapter 5.	Conclusion, Limitations and Future Scope of Work .....	97
5.1	Introduction .....	97
5.2	Novelties (key contributions) of the Present Thesis .....	97
5.3	Fulfillment of the Objectives and Testing of Hypotheses .....	99
5.4	Limitations and Recommendations for Further Research .....	100
5.5	Conclusion.....	101
6	References .....	103
7	Appendices .....	117
	Appendix - A. Creativity Assessment Guidelines .....	117
	Appendix - B. Creativity Evaluation Sheet.....	119
	Appendix - C. Details of Expert Evaluators.....	120
	Appendix - D. Sketches to 3D CAD Renders and Physical Prototypes of Bluetooth Speaker Concepts.....	121
	Appendix - E. Figures of Speech (FoS) Card Tool .....	135
	Appendix - F. Overall Emotive Form Design Approach using Shaping Emotion Framework and Detailed Protocol of Experiments .....	137
	Appendix - G. List of Publications.....	139

## List of Figures

Figure. 1.1:	Process and Method of Literature Review .....	3
Figure. 1.2:	Concept Map of the Critical Analysis.....	4
Figure. 1.3:	Fundamental Product Design Elements affecting Consumer Emotional Response	8
Figure. 1.5:	Conceptual Framework for Factors Affecting Consumer Emotional Response before Product Purchase .....	13
Figure. 1.6:	The Part of Conceptual Framework in focus for the Current Research .....	14
Figure. 1.7:	Designer’s Intent and Consumer’s Realization.....	14
Figure. 1.8:	Emotional Continuity occurs when Designer’s Intended Product Emotions and Consumer’s Emotional Response Overlap .....	15
Figure. 1.9:	Team Roles .....	18
Figure. 1.10:	Sample compiled information with critical points highlighted .....	19
Figure. 1.11:	Research Opportunity Identification Process Workflow .....	20
Figure. 1.12:	Network Visualization of research on the design of smart wearable devices (using VOSviewer).....	21
Figure. 1.13:	Thesis workflow and content of various chapters .....	26
Figure. 2.1:	Experiencing and Expressing Emotions.....	29
Figure. 2.2:	Three Elements of Emotional Design (Source: Norman, 2004).....	30
Figure. 2.3:	Model of Product Emotions (Source: Hekkert and Desmet, 2002).....	31
Figure. 2.4:	Geneva Emotional Wheel (Source: Scherer, 2005).....	40
Figure. 2.5:	SAM Scale for Rating of Pleasure, Arousal, and Dominance Dimensions of the Emotional System (Source: Bradley and Lang, 1994).....	41
Figure. 2.6:	Pictorial Illustrations in PrEmo (Source: Desmet, 2002) .....	42
Figure. 2.7:	Disney Flour Sack, an Illustration of Emotions Conveyed by an Object (Left) and the Sensual Evaluation Instrument Objects (Right) (Source: Isbister, Höök, and Laaksolahti, 2006).....	43
Figure. 2.8:	Taxonomy of the EAMs in Product Design.....	47
Figure. 2.9:	Comparison Matrix for the Identification of Useful EAM based on the Research Context .....	49
Figure. 2.10:	Creativity Process (Source: Torrance, 1962).....	52
Figure. 2.11:	The Three Components of Creativity (Source: Amabile, 1983).....	52

Figure. 2.12: Essential Elements of Creativity (Source: Runco and Jaeger, 2012) .....	52
Figure. 3.1: Model of Creative Process (Source: Amabile,1983) .....	57
Figure. 3.2: Proposed Framework of Shaping Emotions .....	57
Figure. 3.3: Plutchik’s Wheel of Emotion (Source: Plutchik, 1991).....	59
Figure. 3.4: Chair Form Concepts Developed using Curralo’s Approach (a) Aggressiveness Chair; (b) Awe Chair; (c) Love Chair; (d) Optimism Chair; (e) Contempt Chair; (f) Disappointment Chair; (g) Remorse Chair; (h) Submission Chair (Source: Curralo, 2017).....	60
Figure. 3.5: Studio Exercise Method Steps (a) Inspiration Image, (b) Clay Explorations, (c) PU Foam Explorations, (d) Final Form (Source: Chakravarthy, 2014).....	60
Figure. 3.6: Bottle Form Generated using EmotiveModeler (left) and Software Interface (right) (Source: Motersill, 2014) .....	61
Figure. 3.7: Russell’s Circumplex Model (left) and Results of Clay Shaping Exercise (right). (Source: Melcer and Isbister, 2016) .....	62
Figure. 3.8: Stimuli incorporating plant features, human contours, or human facial features. (Source: Wu and Chen, 2015) .....	62
Figure. 3.9: Examples of Design-by-Analogy .....	68
Figure. 3.10: Irony Examples (a) Cyclehoop Car-shaped Bike Rack, (b) Plopp Stool, (c) Toga Chair .....	70
Figure. 3.11: Hyperbole Examples (a) Spring Stool, (b) Pepelkus Outdoor Cigarette Receptacle, (c) Pencil Lamp.....	71
Figure. 3.12: Zoomorphism Examples (a) Firephant, (b) Kastor Sharpener, (c) WooBi Lamp	71
Figure. 3.13: Chiasmus Examples (a) UnBrella, (b) Garbage Watch, (c) Inside Out Champagne Glasses.....	72
Figure. 3.14: Alliteration Examples (a) Chaise Lounge, (b) Love Me Love Me Not Table, (c) Sparks Pendant Lighting System .....	72
Figure. 3.15: Simile Examples (a) Digital Hourglass Watch, (b) Wineglass Chair, (c) Samurai Umbrella.....	73
Figure. 3.16: Alliteration Card .....	73
Figure. 4.1: Ideation Session with Design Students.....	78
Figure. 4.2: Bluetooth Speaker Concept Sketches created by Design Students.....	79
Figure. 4.3: 3D CAD renders of Bluetooth Speaker Concept Sketches.....	80
Figure. 4.4: Visual Representation of the Experiment Design.....	83
Figure. 4.4: Product-Consumer Interaction Scenarios Prior to the Product Purchase.....	90

Figure. 4.5: Concept Sketches, 3D CAD renders, and Physical Prototypes ..... 91

Figure. 4.6: Variety Facor Rating in T1 and T2 ..... 96



## List of Tables

Table. 1.1:	Emotions vs Feelings .....	5
Table. 1.2:	Categories Emerged through the Literature Review and Studies Related to those Categories .....	10
Table. 1.3:	The particulars of the conducted interviews.....	23
Table. 2.1:	Benefits and Drawbacks of Five Theories of Product Emotion .....	33
Table. 2.2:	Shortlisted EAMs for Review .....	35
Table. 2.3:	PANAS Words.....	39
Table. 2.4:	Identification Criteria.....	48
Table. 3.1:	Popularly used Creativity Tools for Generating Ideas.....	63
Table. 3.2:	Summary of Creative Ideation Tools (advantages and limitations).....	66
Table. 3.3:	Methods for Design-by-Analogy and their limitations.....	68
Table. 3.4:	Use of Design-by-Analogy to Develop a New Form Ideation Method.....	69
Table. 3.5:	Figures of Speech in English and their Meaning in the Current Context.....	70
Table. 3.6:	Indicators and Associated Adjective Pairs.....	75
Table. 4.1:	Most commonly used electronic devices .....	78
Table. 4.2:	One-Sample Kolmogorov-Smirnov Test for Normality for Attribute Ratings in T1 .....	84
Table. 4.3:	Shapiro-Wilk Test for Normality for Attribute Ratings in T1 .....	84
Table. 4.4:	One-Sample Kolmogorov-Smirnov Test for Normality for Attribute Ratings in T2 .....	84
Table. 4.5:	Shapiro-Wilk Test for Normality for Attribute Ratings in T2 .....	84
Table. 4.7:	Mean and Std. Deviation of Novelty Rating on the Design Concept 1 in T1 .....	85
Table. 4.8:	Ranks.....	85
Table. 4.9:	Test Statistics .....	85
Table. 4.10:	The Wilcoxon Signed Rank Test for Novelty Rating in T1.....	86
Table. 4.11:	The Wilcoxon Signed Rank Test for Novelty Rating in T2.....	86
Table. 4.12:	The Wilcoxon Signed Rank Test for Complexity Rating in T1 .....	87
Table. 4.13:	The Wilcoxon Signed Rank Test for Complexity Rating in T2 .....	87
Table. 4.14:	The Wilcoxon Signed Rank Test for Trendiness Rating in T1 .....	88

Table. 4.15:	The Wilcoxon Signed Rank Test for Trendiness Rating in T2 .....	89
Table. 4.16:	Mean Values of the Creativity Assessment Ratings by Expert Evaluators in T1 and T2.....	93
Table. 4.17:	The Wilcoxon Signed Rank Test for Novelty Rating .....	94
Table. 4.18:	The Wilcoxon Signed Rank Test for Appropriateness Rating .....	94
Table. 4.21:	The Wilcoxon Signed Rank Test for Elaboration Rating .....	94
Table. 4.22:	The Wilcoxon Signed Rank Test for Surprise Rating.....	95



# **Chapter 1. Understanding Emotions and their Role in the Design of Products**

## **1.1 Introduction**

Many researchers have stressed the importance of emotional design because, first, emotionally neutral products do not exist. Any design elicits emotions from consumers, whether a designer intends it or not (Gaver, 1999). Thus, to avoid any undesirable or unanticipated emotional ‘side-effects’ of design decisions, it is necessary to have a prior understanding of the effects of design on consumer emotions (Desmet & Hekkert, 2009). The second reason is, companies often focus on technology-driven products. However, as the market enters into the maturation phase, the technology penetration becomes high, and technically similar products co-exist (Gonzalez et al., 2017). In such circumstances, technology starts losing its potential to become a differentiator, and companies can no more rely only on technology for competitive advantage. At this point, emotional design can be applied as a useful differentiation strategy that utilizes knowledge of consumer emotional response to impart a delightful experience. Consumer researchers also have established that emotions elicited by products add to the pleasure of purchasing, using, and owning them (Hirschman & Holbrook, 1982). Creusen (1998) and Norman (2004) even argued that the emotional aspect of the design is more crucial than the functional one in deciding the market success of a product. Designers, therefore, need to transcend the traditional approach of conceptualizing and optimizing based on function, ergonomics, manufacturing, cost and be more sensitive to what emotions product design evokes from consumers.

Designers devote a substantial period to conceive and develop their design. In comparison, they have an extremely short window of opportunity to convey their design intention to the consumers through their product. The factors like the visual design of the product, often the first point of consumer-product interaction, are utilized to elicit desired emotion (Bloch, 1995). Gorp & Adams (2012) also highlight the importance of evoking emotions to capture consumers’ attention in such situations. The emotions elicited by a product during the first interaction also affect the judgment of other attributes of the product (Jennings, 2000). Therefore, it becomes essential to study the factors which impact consumer emotional response in the ‘Before Product Purchase’ scenario. In this regard, first, it is crucial to understand what emotions are and what their associations to the design are.

## **1.2 Literature Review on the Product Design and Consumer Emotions**

In this study we conducted an integrative literature review, defined as one in which the published research studies are critically analyzed and synthesized into a significant contribution to new knowledge about the theme under study. The new knowledge generated by weaving together

ideas from literature can take different forms such as alternative theory or conceptual frameworks, classification of constructs, reshaping ideas and meanings (Torraco, 2016). The development of an integrative review includes six steps: the selection of research questions, defining the criteria for literature screening, defining categories or themes that emerged from the existing research articles, analysis, and synthesis, logical and conceptual reasoning, implications for future research (Bezerra et al., 2012).

The initial set of questions that this literature review sought to answer were:

- What are the fundamental terminologies in emotion research?
- Which are the factors affecting consumer emotional response in the ‘before product purchase’ scenario?

A systematic search was conducted using online databases: Google Scholar, Scopus, and Web of Sciences. The keywords used for this purpose were “emotional design”, “emotion assessment”, “consumer emotions”, and “emotional response” with limitations to studies conducted in design, consumer research, management, marketing, psychology, cognitive science, philosophy, and technology. The inclusion criteria were: (a) Works written in English language only in the timeframe of January 2000 to August 2020, (b) the presence of the search term in keywords or title, (c) full-text availability, (d) original and relevant articles in the product design and emotion domain. Furthermore, additional papers from reference lists of the articles reviewed were also identified. The initial search resulted in the identification of 715 articles. After the application of inclusion and exclusion criteria, 133 articles remained for our review. Through the assessment of selected articles, four main categories emerged, which are represented in Figure 1.1 The critical analysis of identified literature was conducted phase-wise based on the first two categories.

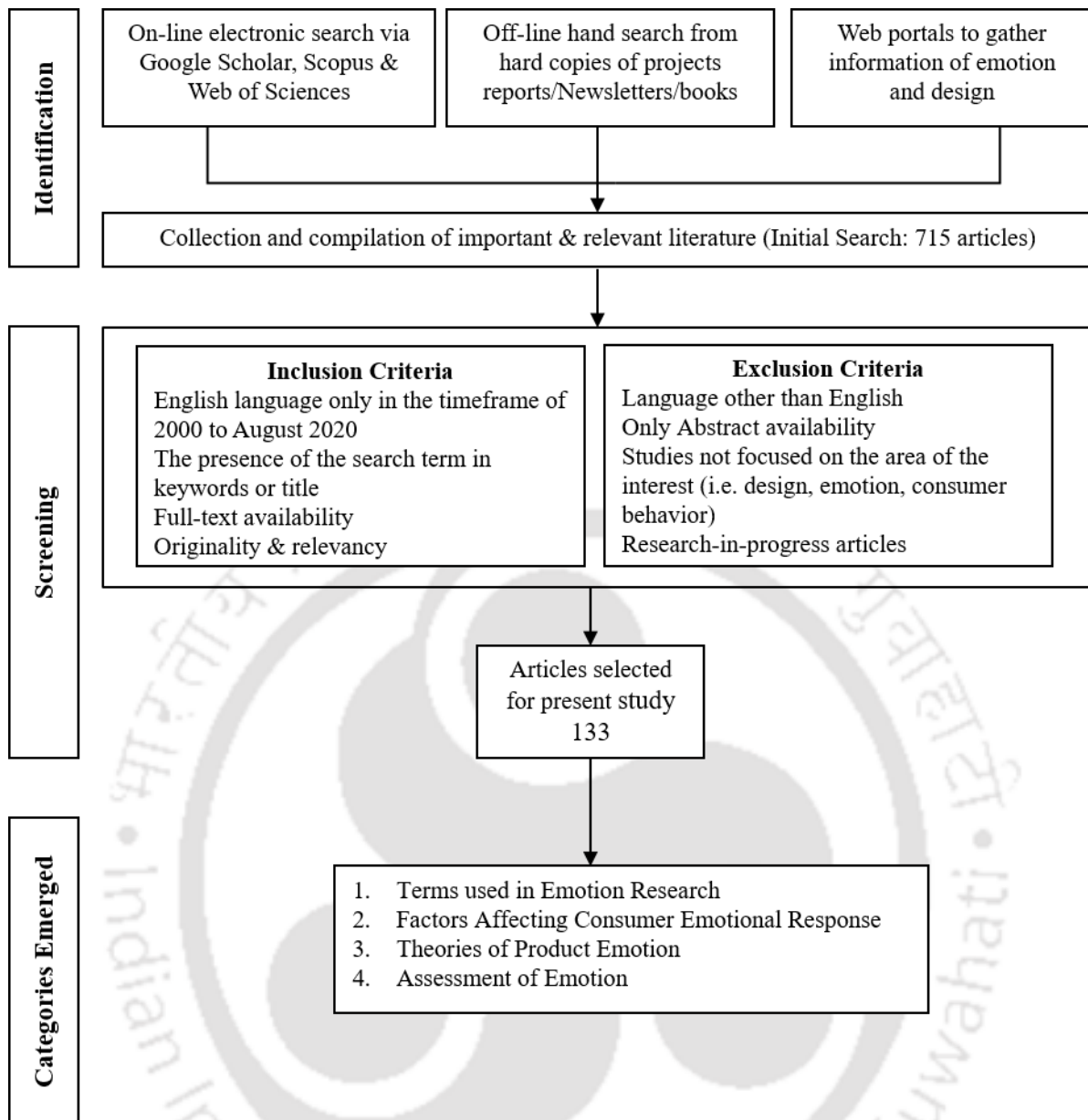


Figure. 1.1: Process and Method of Literature Review

The concept map shown in Figure 1.2 is the visual representation of the categories and sub-categories of the current research topic, created to enhance the understanding and explain the structure of the literature review.

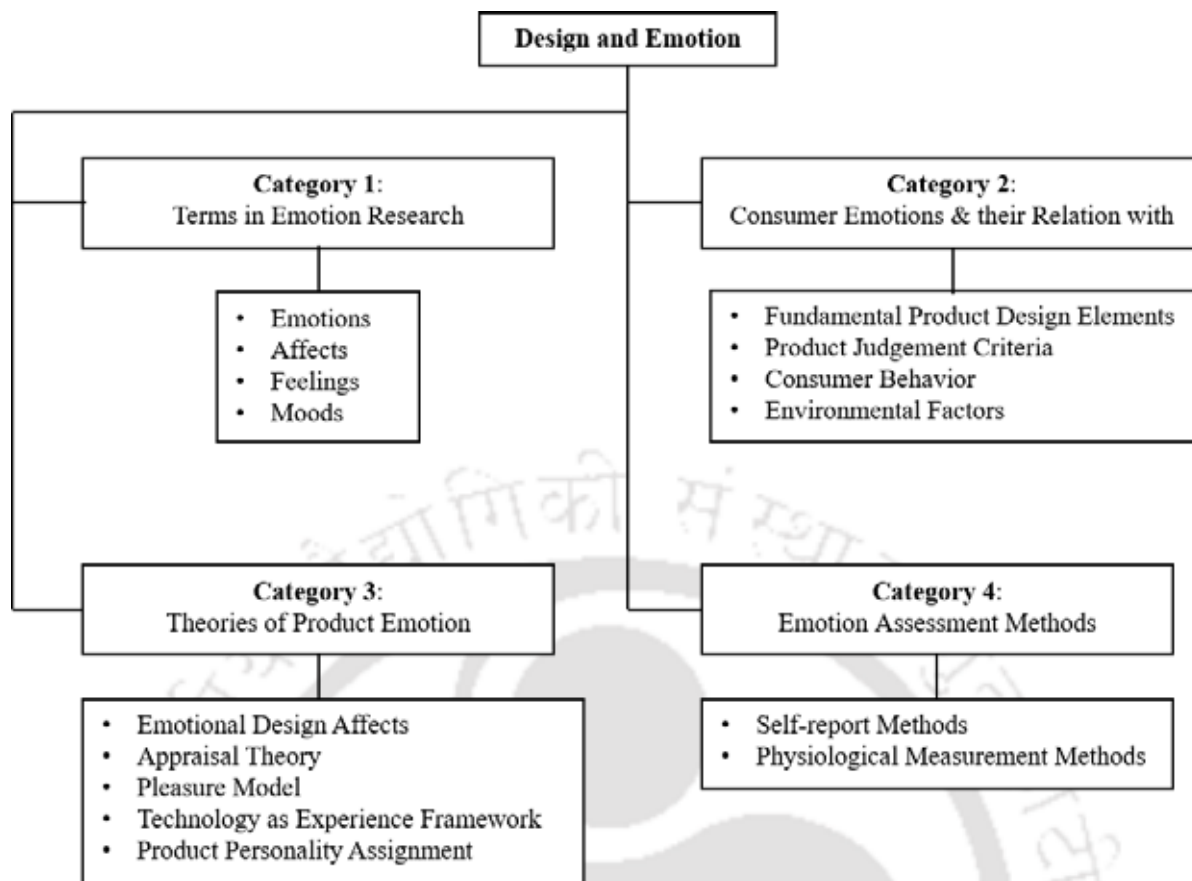


Figure. 1.2: Concept Map of the Critical Analysis

### 1.3 Analysis of Literature

This section presents the analysis of Category 1 and Category 2 of the concept map. The remaining categories are presented in Chapter 2.

#### 1.3.1 Terms used in Emotion Research

The literature discussing emotion often includes terms like ‘affects’, ‘emotions’, ‘feelings’, and ‘moods’. All the terms express various dimensions of emotional experience, and hence it becomes necessary to define each of them. The perspective of other researchers needs to be outlined to understand these terms.

Emotions are considered the mechanisms that trigger when circumstances are favorable or adverse to one’s concern (Hekkert & Desmet, 2002). Emotions are directed at something, and they are generated by actions taking place exterior to the body or thoughts, internal depiction of memories and experiences (Gorp & Adams, 2012). Desmet (2003a) argues that everything humans do has a subconscious shade of emotion. Furthermore, Desmet (2003a) advances the argument stating that emotions have an expressive or physiological component and a subjective experience component. The physiological reactions are emotional responses that create biochemical reactions changing

the physical condition of the body without conscious efforts or reflection (Carlson, 1997). As emotions cause physiological reactions such as eye movement, blood flow, facial expressions, body posture, respiration rate, these physiological manifestations can be objectively measured (Hampton, 2015), and emotion associated with a particular physical response can be detected (Desmet, 2003b). Hayes-Roth, et al. (1998) and Arnold (1960), in their articles, use the terms ‘affect’ and ‘emotion’ interchangeably.

Emotions and feelings are like two faces of the same coin, inseparable yet different. According to Antonio Damasio (1999), professor of neuroscience at the University of California, feelings are the conscious perception of an emotional state. In other words, emotions are the state due to the reaction to the stimuli, and feelings arise when the brain interprets or assigns meanings to these emotions. Feelings (also called moods in literature) are also influenced by personal experiences, memories, beliefs, surroundings (N. Frijda, 1994; Sloman, 2002), and hence they are highly subjective, less intense (Ekman & Davison, 1994) as well as difficult to measure objectively. While emotions are temporary, feelings may last long (Carlson, 1997). The difference between emotion and feeling is summed up in Table 1.1.

Table. 1.1: Emotions vs Feelings

Emotional Responses (affects)	Feelings (mood)	
Produce Bodily Responses	Interpretation of bodily responses	(Carlson, 1997; Damasio, 1999; Desmet, 2003a)
Quick	Less Intense	(Frijda, 1993)
Temporary	Long-Lasting	(Carlson, 1997; Robbins & Judge, 2013)
Objectively Measurable	Difficult to Objectively measure	(Hampton, 2015)

### 1.3.2 Factors Affecting Consumer Emotional Response in the ‘Before Product Purchase’ Scenario

The first impressions about a product are typically formed in the first few milliseconds (Ekman, 1992; Lindgaard et al., 2006). Several aspects like product appearance are responsible for generating these first impressions. Previous research suggests that appearance or visual appeal factors are noticed first, determining how consumers evaluate subsequent experiences (Jennings, 2000; Tractinsky et al., 2000). The other attributes of the product are also judged based on the first impression it creates. For instance, in the case of a very positive first impression, a person may downplay potentially negative aspects (Campbell & Pisterman, 2010). Moreover, an immediate emotional response to a product is critical for engaging consumers and eventually influencing their purchase decision (Gorp & Adams, 2012). Thus, it becomes necessary to study the factors which impact consumer emotional response in the ‘Before Product Purchase’ scenario.

### 1.3.2.1 Fundamental Product Design Elements and Emotions

Literature (Chang & Wu, 2007; Kim & Boradkar, 2002; Ürgen, 2006) confirms that form, material, and color are the fundamental aspects of product design responsible for emotional impact. Thus it is necessary to know the role and capacity of each element in evoking emotions in the first consumer-product interaction.

#### Form

Product exterior form, frequently the first point of interaction for consumers in store aisles or on websites, is the way to gain consumer notice that can produce long long-lasting impact and ultimately shapes purchase decisions (Bloch, 1995). Product form communicates a message coded by the designer to the consumer by acting as a bridge between them. Spontaneous emotions elicited by the visible structure of the product overshadow many other aspects (Jacobs, 1999). Ultimately, a product's market success depends upon its ability to evoke emotions in the consumer (Giannini & Monti, 2002). Designers can create products that can influence consumer's visual impression with the help of variation in design elements (e.g., attributes of the form like line, surfaces) considering design principles (proximity, similarity, symmetry) (Coates, 2002; Lauer & Pentak, 2012). To achieve this, designers must have a clear understanding of the characteristics of design elements and design principles.

#### Material

The product appreciation by consumers starts with acknowledging the design of the surface (Chang, 2018). A well-designed product surface through a conscious choice of material texture, graphics, printed or engraved logo can help achieve emotional stimulation through visual communication. A logo, which is nothing but a symbolic representation through graphics, texts, and shapes, could create a consumer's deep emotional attachment with a product by communicating a memorable and symbolic meaning. Therefore, subtly manipulated material surface elements are an effective means of the visual design of the product to elicit intended emotions. Norman (2004) also affirmed that the visceral level of emotions is influenced by by-product material, and it also results in an immediate visceral reaction. The research findings (Ashby & Johnson, 2003; Crippa, Rognoli, & Levi, 2012; Hilton, 2008; Karana, Hekkert, & Kandachar, 2009; Rognoli, 2010) state that consumer interaction with the product material is composed of seeing it, feeling the texture, hearing its sound by tapping on it and inhaling its smell. An elaborate combination of visual, tactile, smell and audio sensory stimuli from the product material shapes the overall emotional experience for the consumer.

#### Color

The role of color in influencing the psychology of the consumer has been studied extensively in marketing and consumer research (Westland & Shin, 2015). Color is an essential and influential mode to build and sustain brand images and corporate identity in consumers' minds (Madden et al., 2000). Kumar (2017) found that the quality of the brand can be communicated effectively through color. Tutssel (2001) argued that consumers could judge a brand by its color without reading the written matter. The pertinent use of color can create a long-lasting impact and is beneficial for market success. However, color perception is also affected by cultures (Armstrong, 1991) and subsequently learned associations. Moreover, age, gender, ideology, and ethnicity too are significant in color preferences. Thus, companies like Coca-Cola, Nestle, Procter & Gamble are seen paying extreme attention to the brand colors.

Form, material, and color are the factors that exist at the forefront of our awareness. Furthermore, several other background characteristics like intended function, ergonomics, constraints in the manufacturing method, production budget influence the design outcome. The design brief is created keeping these factors in mind and hence termed as 'Design Objectives'. For instance, a design team may be given a target or objective of designing a product with a fixed production budget. In that case, product material/color selection is constrained because of the objective set beforehand. The design team sets the brief, keeping these constraints in mind, and these are the objectives that need to be achieved along with creating desired consumer emotional response. The Design Objectives are nothing but the extraneous variables influencing the design of the product (external stimuli) directly and eventually consumer emotional response. Further, seminal studies of emotions in consumer research such as Izard (1977), Westbrook (1987), Oliver (1993), and several others showed that at the most abstract level, an emotional response is either a positive response or a negative response. The constructs discussed in the above sections are represented visually in Figure 1.3.

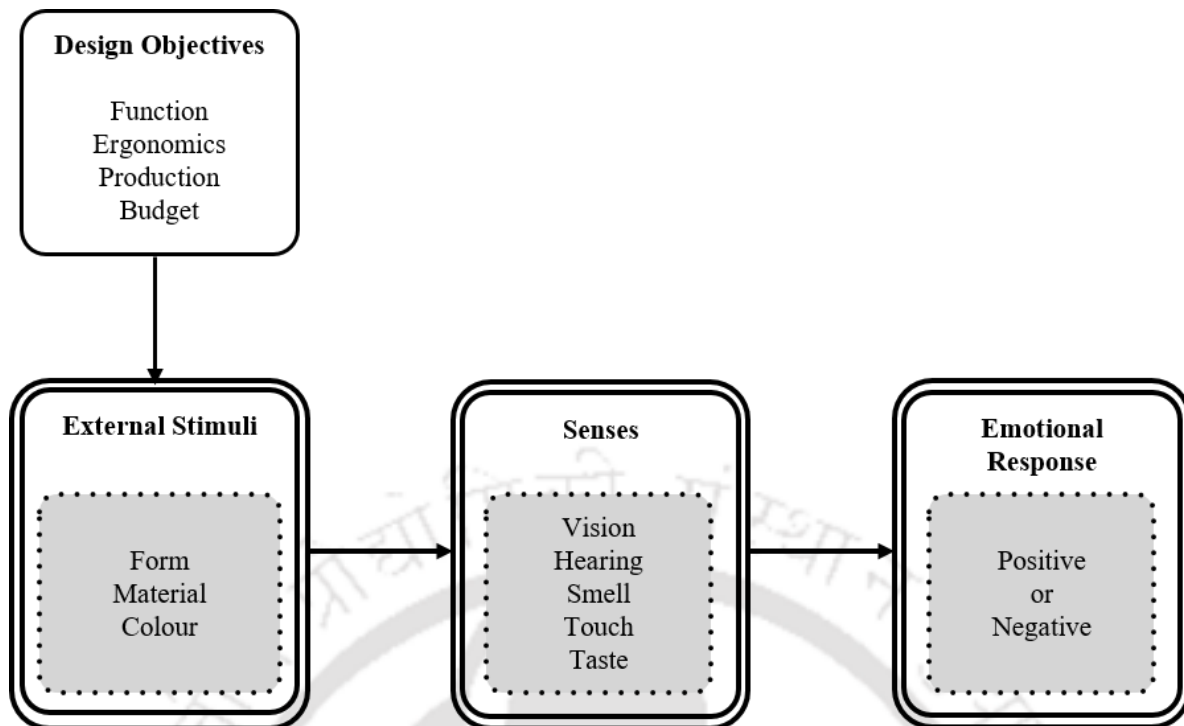


Figure. 1.3: Fundamental Product Design Elements affecting Consumer Emotional Response

### 1.3.2.2 Product Judgement Criteria and Emotions

Product form, material, and color can influence consumers roaming in retail aisles of shops without any particular purchase intention. However, if a consumer has predetermined judgment criteria (such as price, utility, quality, brand) about purchasing a product based on his needs, these factors influence his emotional response. A consumer with an intention to buy a product evaluates it on each of these predetermined factors, and products that do not fulfill his judging criteria will be avoided. Tversky (1972) calls this ‘elimination by aspect’. Moreover, product judgment criteria also influence the design as well. For instance, a brand would want to stick to its brand guidelines while designing a new product to maintain its identity. These brand guidelines determine the selection of form, material, color.

Marketing directed at the quality of the product also influences consumer emotions. For example, consider a consumer who wants to buy edible oil. Marketing taglines such as “oil with a unique blend of taste with health” may create thoughts about how good the oil is for health and also has a taste. These thoughts may ultimately result in positive emotions about the oil. The business of brand marketing uses consumers’ emotional connection with the brand rather than highlighting product benefits (Woods, 2004). Brands tend to elicit positive emotions in the consumers having a positive experience with them previously (Yu & Dean, 2001) and are likely to be loyal to that brand.

Brand awareness plays a crucial role as consumers select and evaluate products. Different

businesses use “brand strategy” as their primary goal in the process of promoting and selling goods to effectively grow their market share and create consumer brand loyalty for repeated purchases. Research findings show a significant effect of advertising on brand awareness and its popularity. Moreover, products with high brand awareness could better acquire positive emotional responses of consumers (Chang & Chang, 2014).

Most of the parameters mentioned above belong to the broader concept of quality. Quality is defined by Juran & Godfrey (1998) as product characteristics that fulfill consumer requirements and provide them satisfaction. Consumers have different perceptions of a quality product depending on their willingness to pay, preference, and usability expectations.

#### 1.3.2.3 Consumer Behavior and Emotion

In the perspective of design, consumer behavior response can be characterized by the approach or avoid action of the consumer (Bitner, 1992; Donovan et al., 1994; Mehrabian & Russell, 1974). In the ‘before product purchase’ scenario, the approach activity reflects the greater engagement of the consumer with the product exploring, viewing, listening, or touching it, and avoiding action is just the opposite of approach action. Previous research points out that positive emotion is generally associated with positive consumer behavior towards products (Adaval, 2001; Barone et al., 2000; Isen et al., 1987; Norman, 2004). It implies that if a product can elicit positive emotions, it will be favored by consumers. However, Gorn et al., (1993) also argued that if the consumers are made aware of their emotional state, then it does not create bias in their judgment. Sometimes, even though the product elicits negative emotions, it may result in positive consumer behavior. For example, the most common notion about medicine is that bitter is the test, more is its effectiveness. Thus, even if medicine taste evokes a negative sense of emotions, consumers tend to showcase approach behavior towards it.

#### 1.3.2.4 Environmental Factors

The purposeful design of the shopping environment to influence consumers is considered to enhance consumers’ emotional responses. The appropriate design of space is eventually expected to positively influence the attitude, perception, and behavior of consumers (Bellizzi & Hite, 1992). Levy et al. (2017) showed that the space layout is a significant contributor in evoking a specific emotional response. Mehrabian and Russel (1974) proposed that emotional states mediate the effects of the environment on behavior. Furthermore, several other studies also supported this framework (Babin & Darden, 1996; Donovan & Rossiter, 1982). A study exploring the effect of mall décor on consumers showed a significant impact in terms of consumer emotional response (Chebat & Morrin, 2007). Bruner (1990), through an investigation, found that music can impact

consumers' emotional responses and expenditure patterns. Moreover, in their experimental approach, Baker and colleagues (1992) established that a significant relationship exists between the consumer emotional response and ambient factors such as temperature, lighting, noise, music, and ambient scent.

#### 1.4 Conceptual Framework

As a result of analyzing the research contents of product design and consumer emotions, the following key research developments are identified. First, the existing research studies related to product design and emotion have developed a comprehensive knowledge of the complex phenomenon of layered emotional response to products. Several seminal studies like Emotional Design (Norman, 2004), Appraisal Theory (Hekkert & Desmet, 2002), Pleasure Model (Jordan, 2005), Technology as Experience Framework (McCarthy & Wright, 2004), and Product Personality Assignment introduce conceptual models that identify the source of product emotions and attempt to recognize their relevance to product design. However, none of these studies specifically explore the context of 'before product purchase'. Furthermore, the research contribution of the reviewed studies on the Assessment of Emotion is particularly noteworthy. Some of these studies are mentioned in Table 1.2. A number of these studies have developed instruments and approaches for measuring emotions evoked by products. These instruments range from simple pen-and-paper rating scales to high-tech equipment set-ups. In the context of current study, the relationships emerged through the proposed framework could be verified using any of these existing suitable emotions assessment methods in future research.

Table. 1.2: Categories Emerged through the Literature Review and Studies Related to those Categories

Category	Title	(Author(s), Year)
The Terminology used in Emotion Research	Design for Emotion	(Gorp & Adams, 2012)
	A Multilayered Model of Product Emotions	(Desmet, 2003a)
	What's The Difference Between Feelings And Emotions?	(Hampton, 2015)
	The Feeling of What Happens	(Damasio, 1999)
	Varieties of Affect: Emotions and Episodes, Moods, and Sentiments	(Frijda, 1994)
	Organizational Behavior	(Robbins & Judge, 2013)

Category	Title	(Author(s), Year)
Consumer Emotions and their relation with the other factors in the 'before product purchase' scenario	Theory and models for creating engaging and immersive ecommerce websites	(Jennings, 2000)
	Exploring types and characteristics of product forms	(Chang & Wu, 2007)
	Design Basics	(Lauer & Pentak, 2012)
	Materials and emotions: A study on the relations between materials and emotions in industrial products	(Crippa et al., 2012)
	The Relationship Between Consumer Colour Preferences and Product-Colour Choices	(Westland & Shin, 2015)
	Servicescapes: The Impact of Physical Surroundings On Customers and Employees	(Bitner, 1992)
	An Experimental Approach to Making Retail Store Environmental Decisions	(Baker et al., 1992)
	A Fitting Approach to Interactive Service Design: The Importance of Emotional Needs	(Campbell & Pisterman, 2010)
	Retailing Management	(Levy et al., 2017)
	Music, Mood, and Marketing	(Bruner, 1990)
Theories of Product Emotion	Emotional Design : Why we love (or hate) everyday things	(Baker et al., 1992)
	The Basis of Product Emotions	(Hekkert & Desmet, 2002)
	Designing Pleasurable Products	(Jordan, 2005)
	Technology as Experience Framework	(McCarthy & Wright, 2004)

Category	Title	(Author(s), Year)
Assessment of Emotion	Measuring emotion: the self-assessment manikin and the semantic differential	(Bradley & Lang, 1994)
	Designing Emotions	(Desmet, 2002)
	What are emotions? and how can they be measured?	(Scherer, 2005)
	The sensual evaluation instrument: Developing a trans-cultural self-report measure of affect	(Isbister et al., 2007)
	Emotion Recognition based on Heart Rate and Skin Conductance	(Ménard et al., 2015)
	Wearable Emotion Recognition system based on GSR and PPG signals	(Udovičić et al., 2017)
	Sensing, smart and sustainable product analysis methodology through EEG evaluation	(Pedro et al., 2019)
	Human emotion recognition: Review of sensors and methods	(Dzedzickis et al., 2020)

In the critical analysis of literature, we deconstructed the phenomenon of consumer emotional response in the ‘before product purchase’ into its elemental parts. Now in synthesis, we connect these parts to generate new ways of thinking about the topic in the form of a conceptual framework. The framework has been proposed in figure 1.4, taking account of the multiple factors discussed in previous sections that could have a decisive influence on consumer emotions, directly or indirectly, in the ‘before product purchase’ scenario.

Each aspect of the proposed framework can be investigated at a different level of aggregation. For example, the fundamental elements of product design responsible for emotional impact (viz. form, material, and color) make a cluster that is referred to as ‘External Stimuli’. Furthermore, several other background characteristics like function, ergonomics, production, and budget create a different level of aggregation termed as ‘Design Objectives’. The factors at the Design Objectives level are nothing but the extraneous variables influencing the design outcome. Thus, Design Objectives have an indirect influence on consumer emotional response. At a cluster-level analysis, a researcher may study the factors as a group. For instance, in their experimental research, Chang & Wu (2007) investigated the influence of the overall visual design of household products on consumer emotions. They proposed various types and characteristics of the selected factors that would result in a pleasurable consumer response. At the factor level of analysis, one may control

several elements belonging to the same factor to investigate their effect on consumer emotional response. For example, Tyan-Yu et al. (2017) studied congruity among product form elements in enhancing the positive emotional response. At a global cluster level of analysis, a researcher can use different product categories and associated emotional responses for the study. In such a case, the research focuses on the relationship between emotions elicited by a particular product

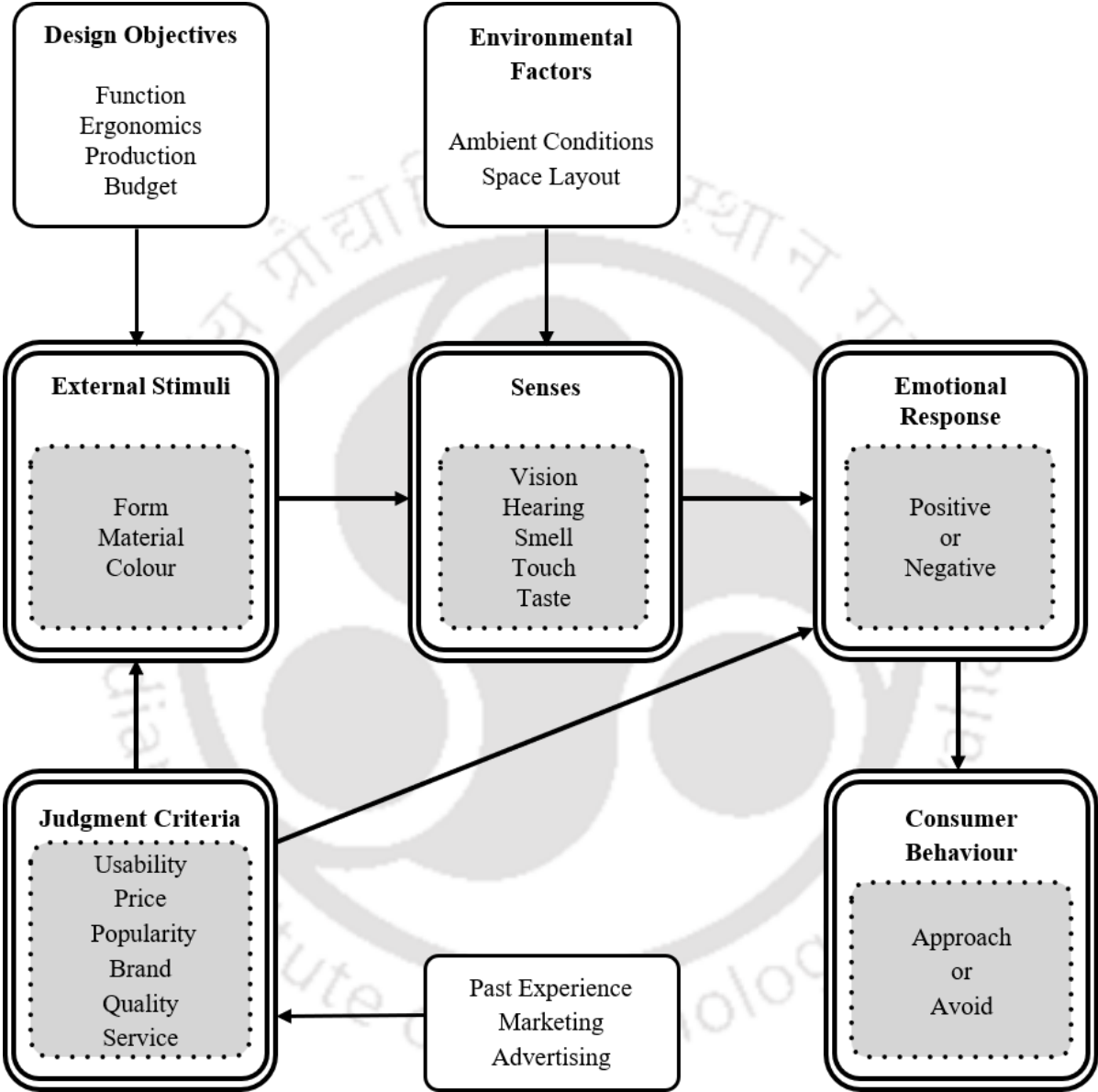


Figure. 1.5: Conceptual Framework for Factors Affecting Consumer Emotional Response before Product Purchase

category, rather than how features of the individual cluster elements are involved in evoking emotions.

Consumer predetermined attributes of product judgment directed by aspects such as utility, price, popularity, brand, quality, and service also shape an emotional response. These factors form a

cluster referred to as ‘Judgement Criteria’. Jordan (1998) argued that the usability of the product is a crucial factor in evoking emotions. Jordan (1998) further added that to produce a positive emotional impact, the property of usability should be crafted carefully in the product development process right at the start. Thus, the usability aspect influences consumer emotions and shapes the fundamental elements of product design. Therefore, the cluster ‘Judgement Criteria’ is shown to affect both ‘External Stimuli’ and ‘Emotion’. Moreover, a substantial literature review indicates that brand marketing (Woods, 2004) and service settings (Ladhari et al., 2017) also influence consumer emotional response. A few additional factors like previous experience (Yu & Dean, 2001), marketing, advertising (Chang, 2018) are nothing but external variables affecting Judgement Criteria.

**1.5 Opportunity Investigation in the Proposed Framework**

In the present research, a new perspective in the form of a conceptual framework involving relationships between various constructs has been proposed. It puts forth the opportunity to investigate the constructs that have not been thoroughly explored previously. For example, consider the part of the framework represented in figure 5.

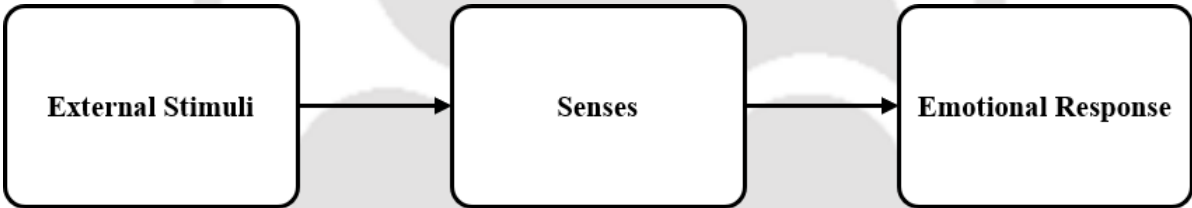


Figure. 1.6: The Part of Conceptual Framework in focus for the Current Research

The constructs in figure 1.5 can be elaborated further as follows: The designer performs the task of physical manifestation of design intent by manipulating product features (external stimuli). Consumers realize the designer’s intent through sensory experience and generate emotional responses from what they sense. Thus, a designer should make a careful choice of the communication channel (form, material) for imparting desired intent. Therefore, figure 1.5 can be modified and reconstructed as shown in figure 1.6.

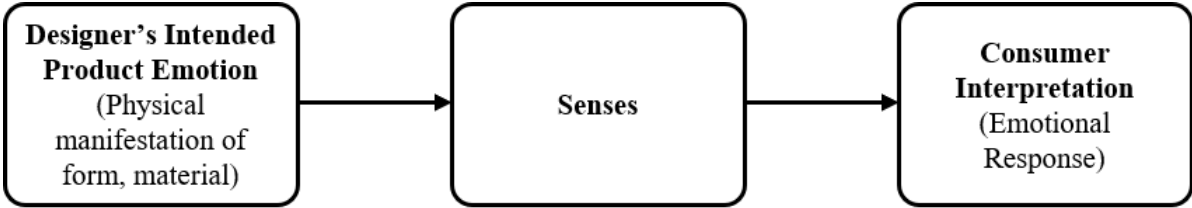


Figure. 1.7: Designer’s Intent and Consumer’s Realization

Previous research points out that differences (discontinuities) will exist between the designer's intent of a product character and consumers' realization of the product character (Ahmed & Boelskifte, 2006; Crilly et al., 2008; Hsu et al., 2000). In this regard, we can state that if a product successfully evokes the same emotional response for most consumers, then there is an emotional similarity (continuity). In other words, if the designer's intended product emotions and the consumers' emotional response overlap, then it can be said that the objective of 'emotional continuity' has been attained (figure 1.7). On the other hand, if the product fails to evoke the same emotional response for most consumers, then there is a significant 'emotional discontinuity', and what is being intended by the designer has not been achieved. This would eventually lead to the design iteration or redesign of the product to minimize or remove the discontinuity.

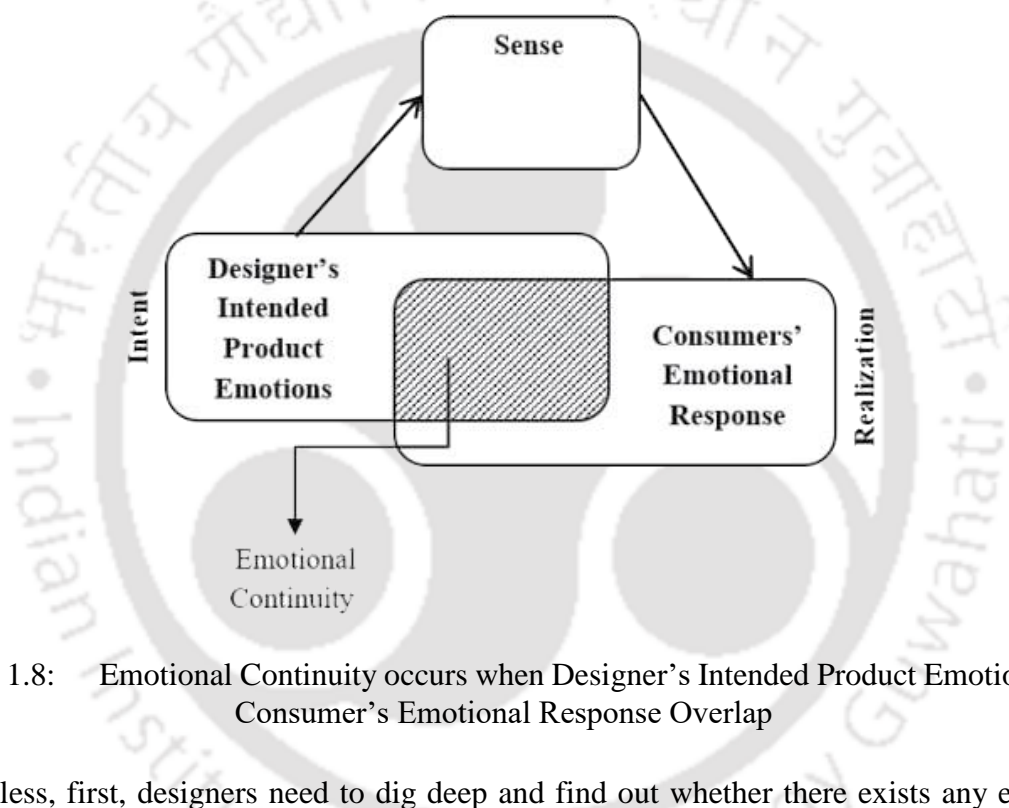


Figure. 1.8: Emotional Continuity occurs when Designer's Intended Product Emotions and Consumer's Emotional Response Overlap

Nevertheless, first, designers need to dig deep and find out whether there exists any emotional discontinuity in the design of the product. The comprehensive review of the literature revealed that the prior work in emotional design falls short in developing a method capable of investigating the emotional discontinuities in the visual design of a product. Thus, future research can be conducted to address the question: how the designer's envisioned product emotions and consumers' emotional responses be compared to reveal emotional discontinuities in the designer's intent and consumers' realization? It would be a practical means to corroborate what a designer envisioned to do and what transpired.

### 1.5.1 Research Gap 1

Research Gap 1 for the current study is presented in this section, which investigates the opportunity

for further research in the proposed framework.

When product designers manifest an intended emotion in the visual design of a product, they have fair and sensible anticipation that through their design skills, they would accomplish the task of evoking intended emotion in a majority of consumers. However, research points out that disconnect will often occur between product aspects expressing designer's intentions and consumer realisation of the product aspects. A designer needs to identify and eliminate this disconnect to ensure the product's success.

**Thus, a design framework is needed to assist designers in emotive form generation and facilitate comprehending consumer emotional responses on the generated forms.**

### **1.6 Development of Research opportunity Identification Framework**

This section presents the Research Opportunity Identification Framework developed and utilized to identify Research Gap 2. The process of developing the framework and its working is explained with a case study.

“Where do I start from?” More often than not, design researchers face this question early on in their research projects. The initial ambiguity frequently results in jumping quickly into the project, which leads to a shift in research focus time and again. To set the initial direction, a researcher needs to have an open mind-set and explore the latest changes occurring in the present world, always thinking about innovative opportunities. Finding new/innovative opportunity areas for carrying out research and defining the initial boundaries of a research space are some of the foremost priorities of a researcher. Although the approach followed by design students is more intuitive and opportunistic to solve any problem, the method followed by other disciplines such as STEM is usually more organized. This often leads to tension when a design research project demands the collaborative work of an interdisciplinary team. In this section, we share an outcome of a study involving an interdisciplinary team working on identifying an opportunity area for design research. The current investigation is used as a case study to illustrate the key phases and their attributes involved in the framework to identify a significant area for conducting a design research project. The framework developed is found to be handy in organizing our thoughts and setting our initial research intent. Based on the study, we propose a pedagogical framework to better equip design researchers to work in collaboration for recognizing the field and scope of a design research project.

A research gap can be defined as a topic or area for which insufficient knowledge restricts researchers' capacity to arrive at a conclusion for a given question (Robinson et. al, 2013). Identifying a research gap or area for investigation often turns out to be difficult for researchers

and academicians (Farooq, 2017) not because of the limited number of issues available for study but due to the complexity involved in formulating a relevant research gap, which is unique and researchable. For designers, the task becomes more challenging due to a defining factor called as ‘design attitude’. Design attitude is working in a manner that is more ‘assertion-based rather than evidence-based’ (Michlewski, 2008). Furthermore, for a researcher, ‘scientific attitude’ encourages working, which is more evidence-based supported by conclusive facts and observations (Rao, 2010). Design attitude and Scientific attitude appear to be contrasting approaches. An interdisciplinary team’s operations could become challenging when members of the team function with such conflicting approaches and working styles. In this regard, not much focus is evident in design education. Thus, it is essential to develop a systematic approach in identifying research gap or area of an investigation while functioning as a team consisting of members from different educational backgrounds. This section of thesis aims to explore and propose a new pedagogical framework to address this issue through investigations where an interdisciplinary team is working to identify opportunity area or research gap for design research. The proposed framework (as shown in figure 1.10) consists of four stages explore, categorize, summarize and evaluate. At each stage, specific team members take the lead to steer the process.

#### 1.6.1 Formation of an Interdisciplinary Team and Team Roles

For the current study, an interdisciplinary team originated at the Indian Institute of Technology Guwahati in Assam, India, to identify an opportunity area for conducting design research. The team consisted of a diverse mix of members from Product Design, Interaction Design, Human Factors, Engineering, and Architecture. According to Belbin, any team has two parts, a functional role, and a team role. The functional role is nothing but the specialized skills a member possesses to perform a profession-based task, and the team role is the attitude and behavior of a member that is put to use for the effective working of a team (Belbin, 1991). Further, Belbin stated nine team roles that can be grouped in three broad categories: action oriented roles – Shaper, Implementer and Completer Finisher; people oriented roles – Co-ordinator, Teamworker, and Resource Investigator; cerebral roles - Plant, Monitor Evaluator and Specialist (Belbin, 1996). These team roles at the different stages of the proposed framework are as shown in figure 1.8.

In the interdisciplinary team formed, the team roles are well-defined, and the necessary members are involved at the required time by the Co-ordinator. The role of a Co-ordinator is to oversee the entire process and assign appropriate people to lead at different stages of the process (The Belbin Team, 2018). Only required people at each stage will mean less frustration (and fewer time-consuming meetings) for everyone involved. Designers often play the role of a Plant in a team. Plants are effective in tackling complex early stages of a process innovatively through their creative thinking

skills. The Shaper keeps the project stick to the deadlines. Teamworker is essential for empathy and averting friction, and the Specialist is necessary when in-depth understanding is called for. The Monitor Evaluator team role, which is to see all the options, strategize and judge accurately (Belbin , 1991), would be best suited for the Categories stage to lead the process. Implementer

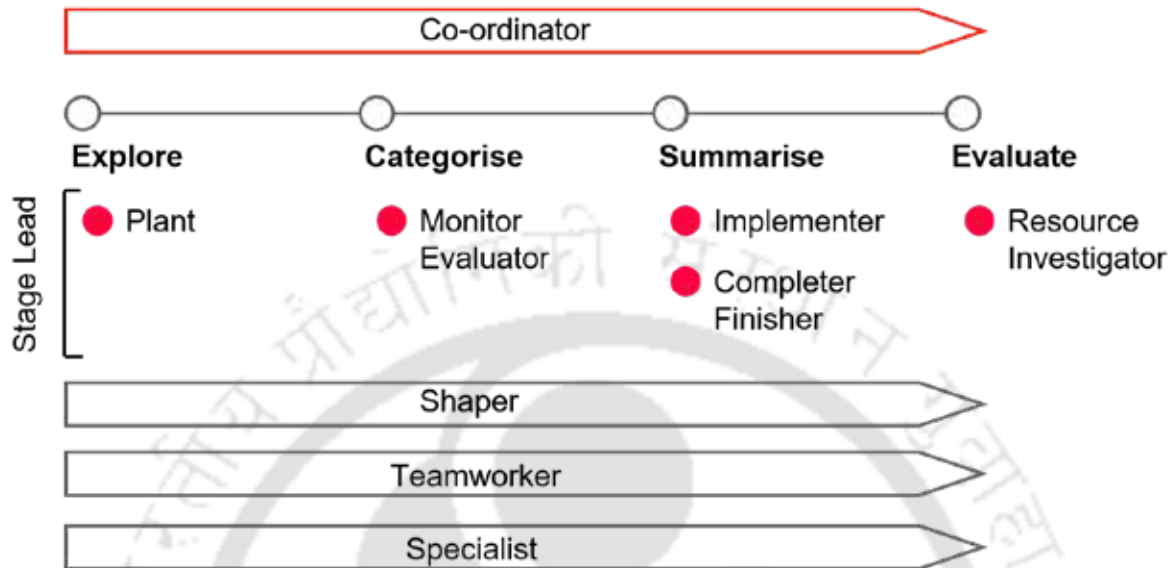


Figure. 1.9: Team Roles

and Completer Finisher can be considered to lead for the Summaries stage because of the qualities like the ability to turn ideas into practical action-based tasks and deliver on time. The Resource Investigator is assigned as a lead in the Evaluation stage, which requires the development of contacts and communication with people through interviews and surveys.

### 1.6.2 The Process of Research Opportunity Identification

To set the initial direction, researchers need to examine various areas, and it requires a lot of reading and analyzing the material from multiple resources. This initial exploration follows a repetitive loop of search, communicate, and group think. As Tom suggested, “First, you need to identify and select relevant information sources, which will mean looking at books in the library, catalogs, databases and on the Internet” (Tom, 2012). The Plant leads the Explore stage.

#### 1.6.2.1 Explore

**Search** - Researchers need to dedicate specific time to search present-day information from various sources keeping an open mind for all kinds of latest information without any bias. An unbiased outlook, in the beginning, can help to find new directions.

**Communicate** - The information collected gathered from the sources should be compiled. The compiled information can have a format that can be easily understood and quickly shared with

others to add comments and highlight critical points while going through it (figure 1.9).

Group Think - Team discussions with a set meeting agenda and specific time limit allow the ideas to exchange through sharing thoughts. It will create understandings of how information is gathered

	A	B	C	D
1	Area	Keywords	Key Points	Source
31	Transportation	Electric Vehicles, Self-drive, Air Pollution, Batteries, Clean Energy, Safety	<ol style="list-style-type: none"> <li>1. The spread of EVs may open up opportunities to provide storage support for renewables via the so-called "vehicle-to-grid" (V2G) option.</li> <li>2. There could be significant advantages from using vehicle-to-grid and associated home-based smart power and storage systems.</li> <li>3. Whether autonomous self-driving car takes off remains to be seen. Safety is a key issue, with some high-profile and fatal accidents occurring with early versions.</li> </ol>	PhysicsWorld ( <a href="https://physicsworld.com/a/an-electric-car-future/">https://physicsworld.com/a/an-electric-car-future/</a> ) Accessed on: 20-11-2019
32	Healthcare	Artificial intelligence, Virtual Reality, Augmented Reality, Trackers, Sensors	<ol style="list-style-type: none"> <li>1. Google's DeepMind created an A.I. for breast cancer analysis. The algorithm outperformed all human radiologists on pre-selected data sets to identify breast cancer, on average by 11.5%.</li> <li>2. VR is being used to train future surgeons and for actual surgeons to practice operations.</li> <li>3. In case of medical professionals, AR might help medical students prepare better for real-life operations, as well as enables surgeons to enhance their capabilities.</li> <li>4. The future of medicine and healthcare is closely connected to the empowerment of patients as well as individuals taking care of their own health through technologies like health trackers, wearables and sensors.</li> </ol>	The medical futurist ( <a href="https://medicalfuturist.com/ten-ways-technology-changing-healthcare/">https://medicalfuturist.com/ten-ways-technology-changing-healthcare/</a> ) Accessed on: 03-12-2019
	Wearables	Seamless, Desirable, Useful, Fashion	<ol style="list-style-type: none"> <li>1. Between conductive fabrics or sensor-clad smart garments, wearables will intertwine so closely with fashion we won't be able to distinguish them apart.</li> <li>2. While energy advancements require more polish to achieve</li> </ol>	Wired ( <a href="https://www.wired.com/insights/2015/02/the-future">https://www.wired.com/insights/2015/02/the-future</a> )

Figure. 1.10: Sample compiled information with critical points highlighted

and steer the project in a definite direction. The team can go back to search for information about the trends that emerged during group think.

### 1.6.2.2 Categorize

The initial efforts to explore the latest information would generate an extensive database of current issues (raw data). This information needs to be organized into a limited number of relevant areas. These areas can emerge through team discussions. Articulation of relevance of these areas and type of information each area would contain helps to manage time and keeps focus on the suitable context of the research. Moreover, an additional search could be conducted in the focus area. In the current study, five areas emerged: technology, society, culture, policy, and business. The relevant area of research was decided to be related to 'smart wearable technology' through team discussions. Further, to dig deeper into the area, several queries were raised about constraints, goals, and desires of the category. For example, what are the technology constraints? what are the technology goals? what are the aspired applications of the technology?

### 1.6.2.3 Summarize

At the end of the analysis of the latest information gathered in Explore and Categorize modes, we put together the keywords, critical observations, emerging patterns into an integrated summary of research relevant areas. It presents a concise overview of the context and reveals hidden details,

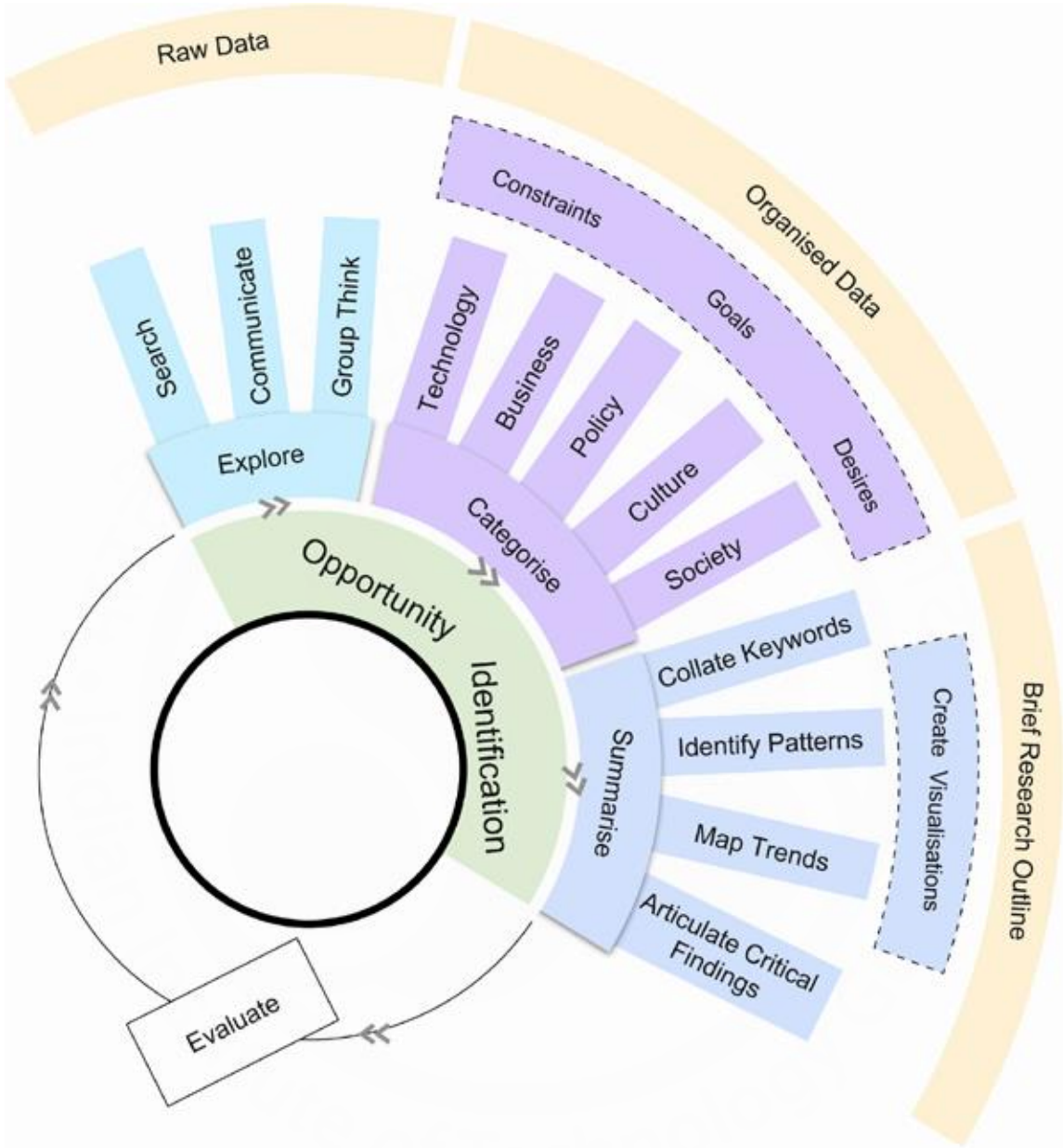


Figure. 1.11: Research Opportunity Identification Process Workflow

trends, insights. It also explains the basic logic behind the research direction. Summarizing the findings is done by collating keywords, identifying patterns, mapping trends, and articulating critical findings.

Collate Keywords - Keywords are nothing but context-specific principal terms that can be used for further search. The use of keywords made the search easier and focused on obtaining relevant information through an extensive database. Analysis of keywords can uncover interesting insights



Analysis of the network visualization showed that the selected keywords predominantly form three clusters (represented in red, blue, and green colors). In a cluster, the size of a node (circle) and its label scale represents the weight of an item. Central nodes of these three clusters are identified as ‘wearable technology design’ (red), ‘textiles’ (blue), and ‘human (physiology monitoring)’ (green). The distance between any two nodes represents their relatedness in terms of their co-occurrence in the literature. In other words, the closer the nodes more is their relatedness in terms of co-occurrence. From the network visualization, it appears that the nodes ‘product design’, ‘human-computer interaction’, ‘human engineering’, ‘watches’ are closely related to the ‘wearable technology design’ node. Based on this, it is appropriate to believe that product design, human-computer interaction, ergonomics, etc., are the central issues in wearable technology design. From the network visualization, it also appears that the importance of the other two clusters, ‘textile’ and ‘human (physiology monitoring)’, is also noteworthy. The ‘textile’ cluster is more related to smart textiles, use of innovative materials, use of 3D printing, etc. and issues in the ‘human (physiology monitoring)’ are closely connected with the design of algorithms for the physiological study of people of different age groups, gender, etc. The team decided to focus research on the issues related to product design, human-computer interaction, ergonomics, etc., in the wearable technology design cluster.

Map Trends - Trends reveal a general sense about the most common areas of research opportunities. Recognizing and understanding trends gives a possibility to position the research so that the research findings would indeed be relevant in the near future. The trend search for the current study shows that the smart wearable devices market is heavily dominated by wrist-worn devices. Moreover, in the past, shipments of smartwatches were way more than that of wristbands, and the trend will continue to be similar in the future (Richter, 2018). Thus the focus object of the current design investigation was determined to be ‘smartwatch’.

Articulate Critical Findings - Organizing the critical findings of keywords, identified patterns, and mapped trends in a comprehensive, fact-based format that can be shared with the research team gives a higher-order overview of the interest area of the research as well as forms the rationale for it. It also helps to establish the extent of boundaries of the research landscape. The critical findings of the current case of smart wearable technology design are as follows:

Explosive growth in wearable technology is witnessed in recent years. Smart wearable devices are eventually going to become an integral part of human life (Cecchinato et al., 2015). When looked at the current wearable market scenario, the companies in this domain appear to have a strong focus on technology-driven innovation. However, as the market enters into the maturation phase, the technology penetration becomes high, and technically similar products co-exist (Gonzalez

et al., 2018). In such a situation, technology starts losing its potential to become a differentiator, and companies can no more rely only on technology to gain the upper hand. Therefore, to attain sustainable competitive advantage, companies are desired to set their focus on design with the user at the center. Emerging technologies like smart wearable devices offer new opportunities for designers to cultivate, enhance, and implement their thoughts and imaginations.

#### 1.6.2.4 Evaluate

After a full understanding of the intended research area is developed at the end of the ‘summarize’ stage, the focus moves towards an evaluation through a more context-specific action such as field visit, expert opinion, online/offline survey to gain as many insights as possible through the industry, professional, expert interaction. Here, the primary purpose is to identify practical, “real world” problems that may be understudied or ignored within academic circles and to make research findings more relevant to practice. The evaluation of the currently selected case of smart wearable technology is explained below.

Globally, the smart wearable market devices market is dominated by multinational corporations like Apple, Google, etc. In India, it can be observed that more and more start-ups are venturing into this territory of wearable tech devices. To get recognized in the competitive market, these start-ups hold out against multifaceted challenges. To get further insights on the design challenges encountered by these organizations, expert opinions are gathered through a few informal telephonic interview sessions with practitioners in wearable devices start-ups. The following table shows the particulars of the conducted interviews.

Table. 1.3: The particulars of the conducted interviews

Sr No	Company Name	Application Area	Location	Designation of interviewee
1	Ducere Technologies	Fitness and Wellness	Telangana, India	Industrial Designer
2	Ducere Technologies	Fitness and Wellness	Telangana, India	Manager- Product Design
3	Lazy Co.	Fashion/Consumer Electronics	Bangalore, India	CEO & Industrial Designer
4	Actofit	Sports/ Health/ Fitness and Wellness	Navi Mumbai, India	Founder & CEO

It was quite evident from the interviews that the smart wearable devices industry in India, which is still in infancy, is relying on the designer’s abilities and experience in seeking design solutions. However, it takes a lot of practice and professional experience for a designer to gain confidence in decision making in industrial projects (Green & Bonollo, 2004). Although traditional design methods have always helped designers deal with practical situations and challenges, what is not

paid sufficient attention in these design methods is the complication of contemporary design concerns. Through industrial interaction, it is quite evident that the contemporary design industry (particularly start-ups) needs a novel design method for the ideation stage, which enhances the designer's idea Generation Ability & Creativity.

At the end of the 'research opportunity identification process' following brief research outline is obtained for the current case: Research gap 2 – **The design industry is in need of a novel design method for the ideation stage which enhances designer's Idea Generation Ability and Creativity.**

### 1.7 Research Gaps

Research Gap 1: A design framework is needed that assists designers in emotive form generation and facilitates comprehending consumer emotional response on the generated forms.

Research Gap 2: The contemporary design industry needs a novel design method for the ideation stage that enhances the designer's Idea Generation Ability & Creativity.

### 1.8 Research Questions

Research Question	Associated Research Gap
RQ1: Does the Emotive Form Design tool assist product designers during the ideation stage to generate different ideas? (Idea generations ability enhancement)	RG2
RQ2: Does the Emotive Form Design tool assist product designers during the ideation stage to overcome the cognitive barrier? (creativity enhancement)	RG2
RQ3: Do these design ideas elicit intended product emotion in a significant number of the target consumers? (emotional discontinuity identification)	RG1

### 1.9 Aim and Objectives

#### Aim

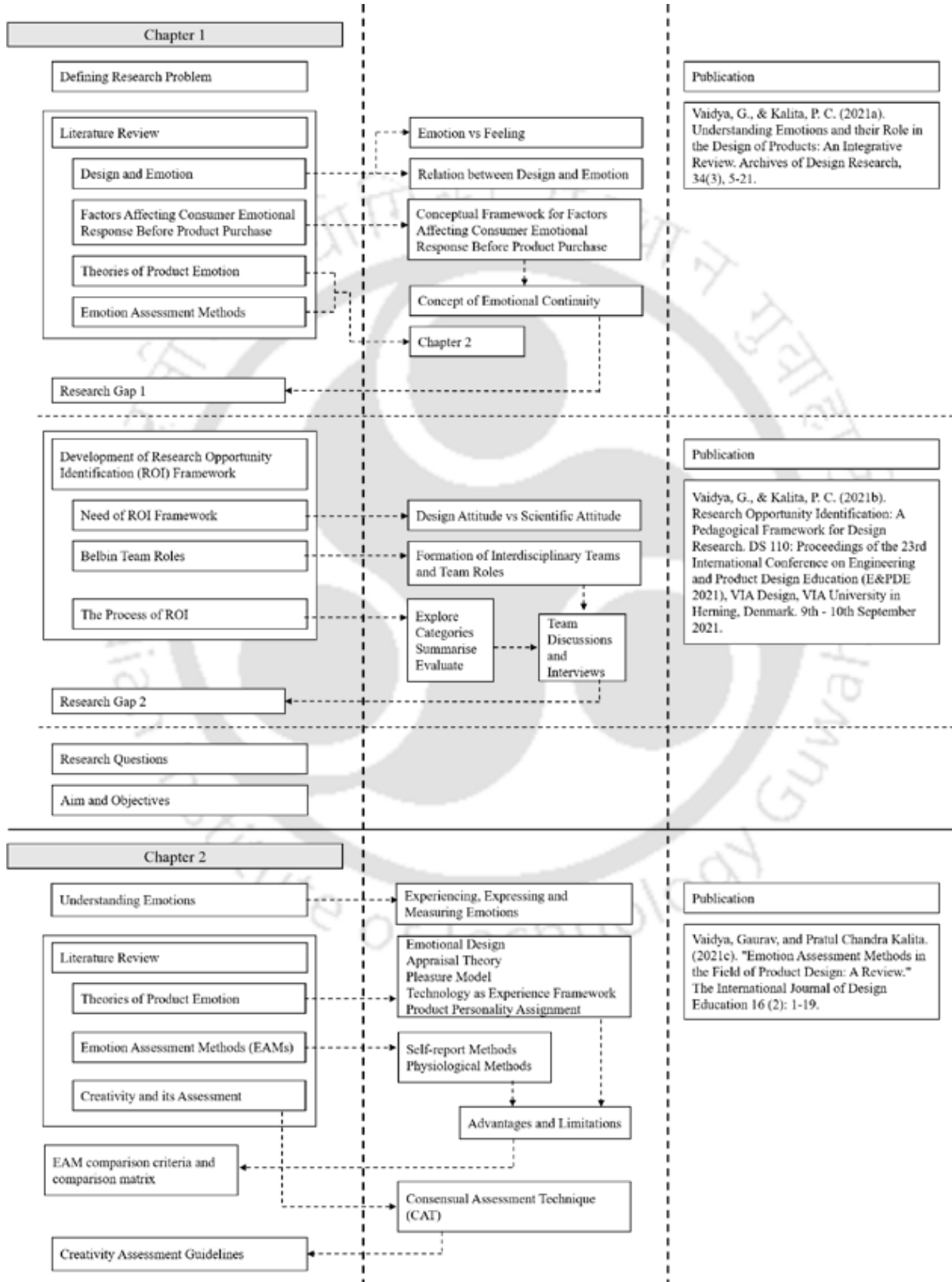
This study aims to evolve an emotive form design framework to assist designers in creative form generation and facilitate comprehending consumer emotional responses on the generated forms.

#### Objectives

- To create an emotive design approach that helps generate a wider range of form design alternatives during the ideation stage.
- To evolve a product form design tool/method for product designers that boosts their

creativity skills in the context of the product emotions and form design.

- To develop a framework to identify the designer’s intended product emotion and to determine whether design ideas elicit intended product emotions.



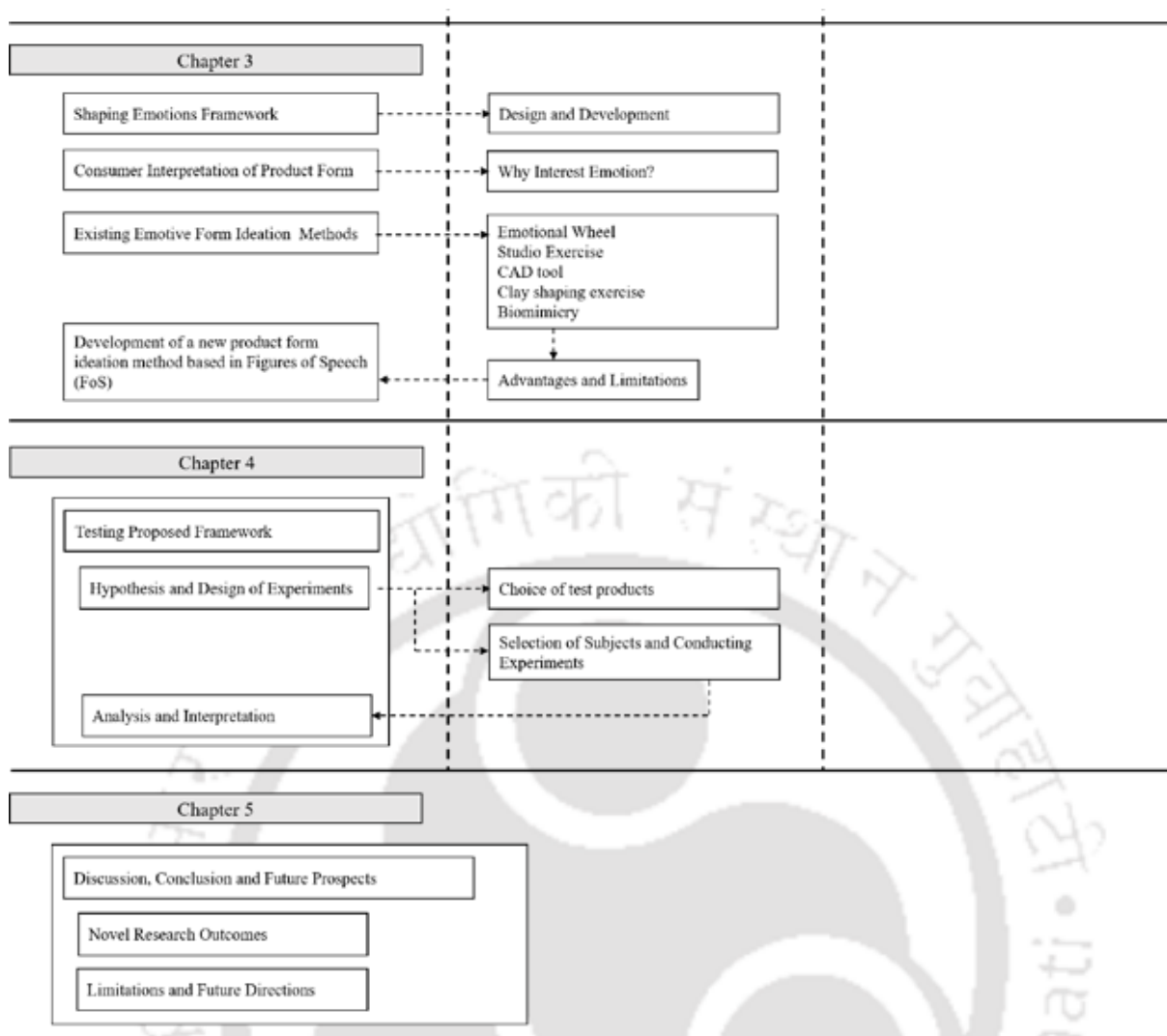


Figure. 1.13: Thesis workflow and content of various chapters

## 1.10 Framework of the Thesis

Based on the study workflow, the thesis report is divided into five chapters. Figure 1.12 illustrates a brief workflow. The research questions, objectives, and hypotheses are addressed in the individual chapters. Subsection 1.10.1 presents the summary of each chapter.

### 1.10.1 Brief of Chapters

A brief summary of the study divided into five chapters in the thesis is as follows:

#### **Chapter–1:** Understanding Emotions and their Role in the Design of Products (present chapter)

The first chapter focuses on the importance of understanding the relationship between emotion and design and how designers can effectively utilize it to discover opportunities for new product conception. It reviews the existing literature related to emotional design and summarizes the research gaps. The research questions, aim of the present research, objectives to achieve, the aim, and framework of the thesis are also presented in this chapter.

## **Chapter–2: Experiencing, Expressing, and Measuring Emotions**

The second chapter describes the phenomenon of experiencing and expressing emotions. It also comprehensively reviews existing emotion assessment methods in product design and performs their comparative analysis. The researchers' perspective of creativity and method used for creativity assessment is also presented in this chapter.

## **Chapter–3: Shaping Emotions Framework**

The third chapter illustrates the existing emotive form ideation methods and presents the need to develop a new emotive form ideation method. This chapter also introduces the design and development of a new framework developed to assist designers in emotive form generation and facilitate comprehending consumer emotional responses on the generated forms.

## **Chapter–4: Validation of Proposed Framework**

The proposed shaping emotions framework is validated by means of statistical methods. The design of experiments for this validation is presented in the fourth chapter. The protocol for conducting the experiments, recorded data, and various tests performed for hypothesis testing are also described in this chapter.

## **Chapter–5: Conclusion, Limitations and Future Scope of Work**

The fifth chapter provides the novelties and critical findings of this thesis. The fulfillment of objectives and testing of hypotheses were also depicted here. This chapter covers the recommendations and suggestions for future study.

## **Chapter 2. Experiencing, Expressing, and Measuring Emotions**

### **2.1 Introduction**

Design has been increasingly viewed as a discipline that attempts to develop products that satisfy the implicit needs of consumers more than merely making things functional. These implicit needs of consumers include emotional and aspirational needs. Therefore, the role of emotions in the design of a product has gained the attention of designers and researchers in recent years. However, capturing and genuinely understanding consumers' preferred product emotion is challenging, as the experience of emotions elicited by a product is a complex phenomenon. Most consumers cannot clearly describe their experienced emotions while they interact with a product. Therefore, several researchers in the emotional design domain have developed methods that focus on understanding and evaluating consumer emotions. Each of these methods has its specific relevance and usefulness, which should be taken into account according to the research context. In Chapter 2 of the thesis, a comprehensive review of the literature on emotion research has been conducted to understand and illustrate the phenomenon of experiencing and expressing emotions. It involves reviewing and critically analyzing seminal studies, theories, and models previously proposed in this domain (viz. Emotional Design, Appraisal Theory, Pleasure Model, Technology as Experience Framework, and Product Personality Assignment). The present chapter also presents a review of the available literature on the most common or most frequently used methods for assessing product-related customer emotions. A keyword search is conducted using online databases to find the relevant methods. The keywords used for this purpose were "assessment of emotion," "product design," and "customer emotions," with limitations to subject areas of design, social sciences, and management. A total of seventeen such assessment methods used previously to evaluate consumer emotions related to product design are selected from the relevant literature for the review. The methods are evaluated based on their benefits and disadvantages. To summarize our results, we propose a taxonomy of the methods selected for the study and develop criteria for comparing these methods for choosing a suitable one for the product design research context. It is expected that the findings of the chapter will assist design researchers, cognitive scientists, and ergonomists in choosing the appropriate emotion assessment method while designing and developing emotional products. In view of research gap 2, it was felt relevant to review the literature describing creativity and its assessment. Thus, this chapter also includes an overview of terms used to define creativity and techniques used to assess creativity.

### **2.2 The Phenomenon of Experiencing and Expressing Emotion**

Arnold (1960) defines emotion as the felt tendency toward anything intuitively appraised as good (beneficial) or away from anything intuitively appraised as bad (harmful). Additionally, the literature

(Norman 2004; Lucas and Diener 2000) affirms that emotions alter the way humans contemplate and act as continuous guides to proper behavior. Desmet also agrees with this perspective and argues that everything humans do has a subconscious shade of emotion. Furthermore, he advances the argument that emotions produce quick bodily reactions arising according to the circumstances (Desmet 2003a). These bodily reactions are emotional responses that create biochemical reactions changing the physical condition of the body without conscious efforts or reflection (Carlson 1997) and giving the advantage of deciding what to do at the time of important events (Paul Ekman 1999). According to Desmet, emotions have an expressive or physiological component and a subjective experience component (Desmet, 2003a). The mechanism of triggering emotion and its components are presented in Figure 2.1.

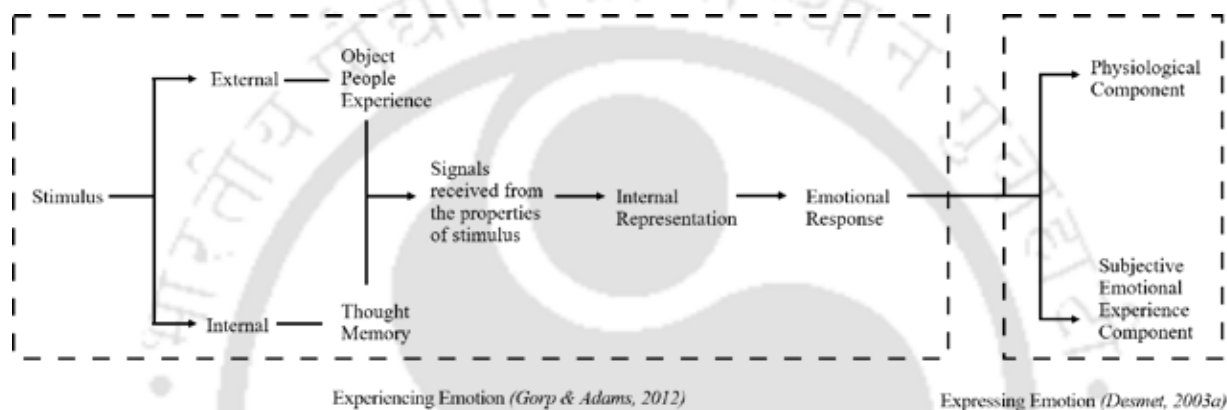


Figure. 2.1: Experiencing and Expressing Emotions

Previous research in product design and emotion has resulted in the development of various theories of product emotions. A comparative study of these theories of product emotions would be beneficial for comprehending this complex phenomenon of product emotion. Therefore, we review seminal theories of product emotion and list down the advantages and limitations of each approach, and report them in the next section.

### 2.3 Theories of Product Emotion

The analysis of five seminal theories of product emotions is presented in this section. Though many theories are available in the literature, in total, the following five theories of product emotions have been identified and examined: (a) Emotional Design, (b) Appraisal Theory, (c) Pleasure Model, (d) Technology as Experience Framework and (d) Product Personality Assignment. These theories are relevant for the current context, first, because all five have explored the complex phenomenon of layered emotional responses, and, second because they all have in different ways attempted to establish links between sources of product emotions and their relevance to product design. Each theory mentioned above has its own positives. It is essential to study these theories to get an improved understanding of the phenomenon of emotional response to design for better emotional product design.

### 2.3.1 Emotional Design

Product appearance (i.e., the visual design of the product) is a communication channel between the designer and the user. Product appearance is the key that governs the consumer interpretation of the product. Crilly and colleagues propose a framework for design as a process of communication that consists of five elements, namely design team (source), product (transmitter), environment (channel), senses (receiver), and response (destination) (Crilly, Moultrie, and Clarkson 2004). In this process, the design and manufacturing of the product is the producer's responsibility. The design team codes the intended message into the product by manipulating its geometry, measurements, surface quality, materials, colors, visuals, details, etc. The consumer interacts with the product in a specific environment, which can be termed as a channel. Consumer senses receive the message transmitted by the product, and the product perception is formed, which results in consumer cognitive response.

Although all human senses impact consumer reaction to the design, it is accepted that visual sense contributes the most in the process (Schroeder 2002; Postrel 2004), and product style usually refers to visual style (Baxter 1995). Monö suggests that the product form that the eye sees generates the viewer's expectation of what other senses will ascertain (Monö 1997). Thus, product appearance has to strike a chord that makes conformity with other human senses (Smets and Overbeeke 1995).

Norman (2004) categorized the human attributes of response in three emotional levels according to the processing that is carried out inside the brain. The levels are visceral, behavioral, and



Figure. 2.2: Three Elements of Emotional Design (Source: Norman, 2004)  
reflective. He further mapped these three levels to product characteristics forming three elements of emotional design: Visceral Design, Behavioural Design, and Reflective Design.

Norman further explained Visceral Design deals with appearance (i.e., visual design) and how

consumers evaluate product appearance through their senses. Human response to objects that offer food, warmth, and protection is usually positive, as humans are genetically programmed through evolution. Behavioural Design refers to the pleasure and effectiveness relating to the usage of a product that consumers find easy to use or gives them a sense of satisfaction. Such products are generally liked more than those having usability issues. Finally, Reflective Design has to do with interpretation, understanding, and reasoning. The consumer may appreciate even a useless product if it has the ability to elicit memories, tell stories or enhance consumer self-image.

### 2.3.2 Appraisal Theory

Different from the concept of Norman's three levels of emotional design, Hekkert & Desmet (2002) proposed the appraisal theory. According to this theory, the consumer's appraisal is the factor that governs emotion elicited by the design outcome. In the experimental model, Hekkert and Desmet divided product emotions into five categories: surprise emotions, instrumental emotions, aesthetic emotions, social emotions, and interest emotions. The model showed that although a product might evoke several emotions, the underlying process that induces emotion in consumers is universal.

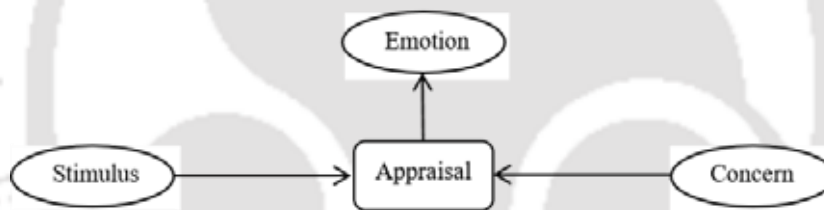


Figure. 2.3: Model of Product Emotions (Source: Hekkert and Desmet, 2002)

This theory resembles Lazarus Theory of Emotion which states that the experience of emotion depends on how an individual cognitively appraises or labels the experience. The appraisal of an event depends upon previous experience, current circumstances, and cultural background (Lazarus 1991). Though the proposed model highlights the cognitive process of emotion generation through appraisal, it does not provide much empirical evidence verifying the connection between design and emotional responses.

### 2.3.3 Pleasure Model

Jordan (2005) proposed the pleasure model. He argued that designers need to move beyond the functionality and usability approach to design. He proposed a pleasure-based approach in which the focus is on the pleasure aspect in designing product experience. His model classified four different types of pleasure, (a) Physio-pleasure; (b) Socio-pleasure; (c) Psycho-pleasure and (d) Ideo-pleasure. Physio-pleasure is associated with pleasure obtained from interaction with products

through our senses, e.g., the tactile pleasure of holding a remote control, the olfactory pleasure of smelling hot coffee. Socio-pleasure is related to joy obtained from our relationship with other people. Sometimes products encourage social interactions, and the pleasure derived from these interactions facilitated by products is termed socio-pleasure. For example, a bakery shop owner may provide a service that facilitates a small public get-together – ‘An evening with Cake’. Psycho-pleasure is to do with the cognitive and emotional responses. In order to use a product, it may be essential to have a certain level of cognitive ability, and product experience may elicit some emotional reactions. Ideo-pleasure is related to peoples’ values. For example, a product manufactured from biodegradable material pertains to the value of environmental responsibilities of the consumer. Although the pleasure model encourages designers to consider product attributes that can exhibit pleasurable experiences in consumers, it does not deal with the biological process of pleasure. Moreover, the model proposes a structured approach to the issue of product pleasure experience and product acceptance based on pleasure. Still, the other dimensions of emotion (e.g., boredom, pride, fascination) remain unexplored.

#### 2.3.4 Technology as Experience Framework

This model was established by McCarthy and Wright (2004), and it analyses elements of consumers’ experience with technology in different phases of engagement with it. The model talks about four threads of overall consumer experience: ‘sensual thread’, ‘emotional thread’, ‘compositional thread’, and ‘Spatio-temporal thread’. The ‘sensual thread’ is associated with the consumer’s sensory organs and their affiliation with a situation. This is comparable to the visceral level described in Norman’s model. For example, children get intensely engrossed in mobile games with all their senses to the extent they cannot be attentive to any activity around them. The ‘emotional thread’ is related to the impact of product use on consumer emotions. For example, irritation caused due to an unresponsive computer. The ‘compositional thread’ involves the relationship between the whole experience and its elements as the consumer makes sense out of it. For example, a mechanic is working on an engine with his passion and commitment to his own handiwork. Each passing moment while working gives him joy and shapes the overall experience in the way of expressing himself. The ‘Spatio-temporal thread’ relates to the effect of space and time on consumer experience. For example, some people choose a quiet place to experience the joy of reading an exciting novel. The framework gives a holistic perspective about consumer experience and its threads. However, the threads mentioned in the framework are not mutually exclusive, and they have a considerable overlapping. For example, both the sensual and the emotional thread deal with the emotional impact of the product use, and one can be unclear of categorizing such consumer experiences based on the threads mentioned. Moreover, the role of human senses in each thread is not described with clarity.

### 2.3.5 Product Personality Assignment

Phillips Design originally developed the approach of ‘Product Personality Assignment’ (PPA). In a pleasure-based approach, the products are seen as ‘living objects’. PPA forms an extension to this idea and proposes that products possess traits that make their personalities. The proposed idea seems over-imaginative as, in a true psychological sense, the products do not have their personalities. However, people may assign personalities to products such as unhelpful, funny, calm etc. based on their reflection of human qualities on to products. For example, an earlier study by Joran reports that one of the participants referred to his radio as an ‘old friend’. Another participant in the same study revealed that she punishes her stereo by thumping it for ruining cassette tapes. The approach demonstrated that different individuals are likely to allocate equivalent personality attributes to the same product, but it falls short in linking personality attributes to product preferences. Moreover, designers having no psychological background may find it challenging to understand the model of personalities proposed by PPA.

### 2.3.6 Benefits and Drawbacks of Five Theories of Product Emotion

The previous section covered a review of five seminal theories for emotional product design. The first two theories (viz. Emotional Design and Appraisal theory) outlined in section 2.3 are effective in lifting the layers of elementary cognitive and emotional processing that is carried out inside the brain, whereas ‘Pleasure Model’, ‘Technology as Experience Framework’ and ‘Product Personality Assignment’ are mainly related to categorization of consumer emotional experience with the product. For better comprehension, table 2.1 given below describes the benefits and drawbacks of the studied theories.

Table. 2.1: Benefits and Drawbacks of Five Theories of Product Emotion

Theory	Benefits	Drawbacks
Emotional Design	Clarifies cognitive processing that is carried out inside the brain at different levels.	Unable to establish empirical methods to evaluate emotional responses validating the model.
Appraisal Theory	Explains the underlying process of emotion generation through appraisal.	It does not provide much empirical confirmation verifying the connection of design and emotional responses.
Pleasure Model	Describes a systematic approach to the issue of product pleasure experience. Explains product acceptance based on pleasure.	Not able to explain cognitive information processing and multiple dimensions of emotion.
Technology as Experience Framework	Explains consumer experience in different phases of engagement with technology.	Unable to explain emotion generation process and the role of human senses in each phase.

Theory	Benefits	Drawbacks
Product Personality Assignment	Effectively relates visual design of a product with individual personalities and emotions.	Not able to establish a link between personality attributes and product preferences.

## 2.4 Measuring Emotion

Since emotions show a strong influence on consumers' product choice and purchase decision (Abraham 1999; Kunnanatt 2004), designers aim to develop designs that elicit consumers' preferred product emotions to achieve a stronger consumer-product connection (Desmet 2002). However, capturing and genuinely understanding consumers' preferred product emotions is extremely difficult as emotions evoked by a product are very complicated (Desmet 2003a). Moreover, most consumers cannot articulate their experience of emotions. Therefore, previous research in the emotional design domain has led to the introduction of several methods that focus on measuring consumer emotional response to designs. Each of these methods requires specific resources and generates a different type of data related to the consumer's emotions. Hence, one needs to be careful while choosing a method based on the context of the research undertaken. This section of the thesis aims to review seminal methods used to assess emotions evoked by the design of a product and propose criteria for selecting an appropriate one based on research settings in the context of product design.

A few previous studies have also attempted to compare the existing Emotion Assessment Methods (EAMs). For example, in his work, Desmet (2003b) had performed a comparative analysis of verbal and non-verbal EAMs and created a new method, PrEmo, incorporating the advantages of existing EAMs. However, his work was mainly aimed at developing a new approach to emotion assessment and had little information on the particulars of each of the existing EAMs. Similarly, Isomursu et al. (2007) compared five EAMs—two existing and three self-created methods. However, their study had a specific context focused on mobile applications in field settings. Therefore, the study used a unique evaluation criterion that was context-specific. Moreover, the study presented only the advantages and disadvantages of the compared methods but failed to propose measures for choosing one EAM based on different research settings. A few other studies (Calvo and D'Mello 2010; Zeng et al. 2009) mainly focused on physiological EAMs. None of the studies mentioned above focused on developing criteria for selecting a suitable EAM in the product design context. Therefore, the current work can be differentiated from the previous ones in terms of its emphasis on comparing EAMs in the product design context to develop criteria for selecting a suitable EAM.

A keyword search was conducted in academic databases such as Google Scholar and Scopus

for peer-reviewed journals using search terms “assessment of emotion,” “product design,” and “emotional response,” with limitations to subject areas of design, social sciences, and management. The literature screening criteria were: (a) works written in the English language, (b) published between January 2000 and December 2020, and (c) full-text availability. The initial search resulted in the identification of 113 relevant studies. The criteria for the identification were the studies related to the fields of product design and visual design of products. Furthermore, additional papers from reference lists of the articles reviewed were also identified. A total of seventeen methods—broadly categorized into (1) self-report methods and (2) physiological methods—is selected for the review. Table 2.2 represents the shortlisted EAMs for review.

Table. 2.2: Shortlisted EAMs for Review

Name of the Method	Authors, Year	Purpose	Studies Based on the Method
<b>1. Self-Report Methods</b>			
Semantic Differential (SD) Method	Osgood 1957	To capture emotions evoked by objects, events, ideas, etc.	Footwear Design (Alcántaraa et al. 2005), Automobile Design (Warell 2008)
Semantic Environment Description (SMB) Method	Küller 1975	To evaluate the overall impression of an environment.	Car Interiors (Karlsson, Aronsson, and Svensson 2003),
Positive Affect and Negative Affect Schedule (PANAS)	Watson, Clark, and Tellegen 1988	To measure the consumer emotional response to products on 20 items describing emotions.	Aromas of Phytonutrient Supplements (Kuesten et al. 2014)
Kansei Engineering (KE)	Nagamachi 1995	To identify “psychological feeling” people have with objects, circumstances, or environments	Seat Design (Barone, Lombardo, and Tarantino 2009), Sofa Design (Yamada et al. 1999), Lift Truck (Schütte, Schütte, and Eklund 2005)
Geneva Emotional Wheel (GEW)	Scherer 2005	To detect the intensity of one or more emotions.	Classification of Emotion expression on Robots (McGinn and Kelly 2018)
Self-Assessment Manikin (SAM)	Bradley and Lang 1994	To evaluate the pleasure, arousal, and dominance connected in response to an object or event.	Emotional Response to colors (Suk & Irtel, 2008)

Name of the Method	Authors, Year	Purpose	Studies Based on the Method
PrEmo	Desmet 2002	To evaluate 14 emotional reactions to product appearances.	Design for Wow (Desmet, Porcelijn, and van Dijk 2007), Material and Emotion (Crippa, Rognoli, and Levi 2012)
Sensorial Quality Assessment Method (SEQUAM)	Bonapace 2002	To establish a link between the physical characteristics of a product and consumers' sensorial responses to them.	Yacht Design (Nicolantonio et al. 2016)
Sensual Evaluation Instrument (SEI)	Isbister, Höök, and Laaksolahti 2006	To use sense of touch to evaluate emotional state.	Development of a trans-cultural self-report measure (Isbister et al. 2007)
Relative Subjective Count (RSC)	Picard and Daily 2005	To compare the variance in the apparent number of interruptions to the actual number of interruptions for assessing the emotional state.	Stress Monitoring (R. W. Picard and Liu 2007)
Cued Recall Debrief (CRD)	Omodei and McLennan 1994	To register information regarding consumer emotional experiences without interrupting consumer-product interaction.	Users' Affective Experiences (Bentley, Johnston, and Baggo 2005)
<b>2. Physiological Methods</b>			
Electroencephalography (EEG)	Britton et al. 2016	To evaluate valance and arousal dimensions of emotion by recording brain signals.	Product Analysis (Pedro et al. 2019)
Electrocardiography (ECG)	Internation Neural Network Society 2018	To measure the heart activity to evaluate emotions.	Video-base Stimuli (Ménard et al. 2015)
Electromyogram (EMG)	Bartlett et al. 2003	To measure muscle activity to evaluate emotions.	Automated Emotion Recognition (Dzedzickis, Kaklauskas, and Bučinskis 2020)

Name of the Method	Authors, Year	Purpose	Studies Based on the Method
Galvanic Skin Response (GSR)	Critchley 2002	To measure skin resistance to evaluate arousal state of emotion.	Use of Image Stimuli in Emotion Recognition (Udovičić et al. 2017)
Respiration Pattern (RSP)	Egger, Lay, and Hanke 2019	To measure one's rate of respiration and respiration pattern to assess emotional state.	Music and Emotions (Kim and André 2008)
Speech Recognition (SR)	Banse and Scherer 1996	To evaluate variations in the vocal cues to know about the arousal dimension of emotion.	Neural Networks in Emotion Recognition (Nicholson, Takahashi, and Nakatsu 1999)

## 2.5 Self-Report Methods

The methods in this category follow the “user-centered” design approach in which consumers are utilized as a designing resource to get a better understanding of their needs, issues, and aspirations (McDonagh-Philp and Lebbon 2000). The user-centered design approach includes standard user research techniques such as in-depth interviews and focus groups. In interviews and focus group techniques, consumers are asked to answer particular questions to discover their opinions, concerns, and experiences. The consumers are probed to report their own behavior, intentions, etc., directly, and their responses are taken as inputs for the design process. However, it has been referred to in the literature that the emotional response to a product is not easy to articulate (Izard 2009). Thus, interviews and focus group techniques may not be as effective in identifying a consumer's emotional needs. Therefore, researchers have adopted some more methods that aim to investigate consumer emotions as expressed by them. These methods are further categorized into (1) Verbal Self-report, (2) Pictorial Self-report, (3) Sensorial Self-report, and (4) Recall Self-report.

### 2.5.1 Verbal Self-report

In this category of methods, the consumers are asked to self-report their emotional experience in verbal terms, i.e., in the form of words and adjectives describing their emotional state.

#### 2.5.1.1 Semantic Differential (SD) Method

Osgood's semantic differential (SD) method is used to capture emotions evoked by objects, events, ideas, etc. (Ploder and Eder 2015). The SD method consists of a questionnaire that asks

participants to rate an entity on a multi-point rating scale. The scale has bipolar adjectives such as happy-sad, desire-disgust, etc., at either end of it and a neutral zero point at the center. Alcántara et al. (2005) employed the SD method for casual footwear perception study. In their study, participants sit opposite the footwear without touching them, just like looking at a shop window. The participants are then asked to fill in answers to a questionnaire on a five-point SD scale. Their study showed that the SD method is suitable in assessing consumers' perceptions of products. However, Schifferstein (2010) argues that the SD method based on the verbal representation of emotions involves language processing. Thus it is more likely that the method evaluates the affective meaning of objects rather than emotions (Schifferstein 2010).

#### 2.5.1.2 Semantic Environment Description (SMB) Method

The Semantic Environment Description Method (Semantisk Miljö Beskrivning in Swedish), developed by Küller (1975), claims to evaluate the overall impression of an environment such as a room, a building, or a landscape. The method is seen as an effective way to obtain quantitative data on important "intangibles" such as consumer emotions. In this method, participants answer a questionnaire on a semantic scale consisting of thirty-six adjectives. The adjectives are clustered into eight factors: pleasantness, complexity, unity, enclosedness, social status, potency, affection, and originality. Although the method is commonly used for the evaluation of environments, it has been used by researchers to evaluate the overall impression of a vehicle interior (Karlsson, Aronsson, and Svensson 2003). The study conducted by Karlsson, Aronsson, and Svensson (2003) showed that the SMB method is easy to administer and flexible enough for cross-cultural evaluations. While the result of the study has made a significant contribution, the SMB method is regarded as a method for a specific purpose rather than a more comprehensive and universal method.

#### 2.5.1.3 Positive Affect and Negative Affect Schedule (PANAS)

Positive Affect and Negative Affect Schedule (PANAS) developed by Watson, Clark, and Tellegen (1988) is a self-report questionnaire consisting of twenty words (ten positive and ten negative) that are used to assess emotions. Consumers are asked to describe their state of emotion while interacting with a product. They represent their emotional state by providing a rating on each of the twenty words using a 5-point Likert scale. Kuesten et al. (2014) have employed PANAS to measure consumer emotions associated with aromas of phytonutrient supplements. The study shows PANAS to be an effective method in the measurement of consumer emotional response to products. Moreover, the validity and reliability of PANAS have been tested (Watson, Clark, and Tellegen 1988). Since PANAS is a self-report method, the outcome may get affected as people can exaggerate or play down their emotions. Moreover, some studies have argued that the PANAS is

very lengthy or that most of the words used in this method for describing emotions are redundant (Thompson 2007).

Table. 2.3: PANAS Words

Interested	Irritable
Distressed	Alert
Excited	Ashamed
Upset	Inspired
Strong	Nervous
Guilty	Determined
Scared	Attentive
Hostile	Jittery
Enthusiastic	Active
Proud	Afraid

#### 2.5.1.4 Kansei Engineering (KE)

The concept of Kansei Engineering (KE) was established by Nagamachi (1995). According to him, the word Kansei means the “psychological feeling” people have with objects, circumstances, or environments. In KE, consumers are probed to convey their Kansei (psychological feeling) in words on their interaction with a product. The collection of these words is called “Kansei Words.” Further, these words are analyzed to determine a correlation between Kansei words and product features. Any new design is evaluated against these established relations to identify how close the tested product is to the ideal product. There are numerous studies such as seat design (Barone, Lombardo, and Tarantino 2009), sofa design (Yamada et al., 1999), and forklift truck (Schütte, Schütte, and Eklund 2005) that have implemented KE to identify and translate consumers’ emotional needs for product design. However, most of the studies have used final product images for evaluation rather than product concepts or actual products (Bongard-Blanchy, Bouchard, and Aoussat 2013). Thus, KE has a limited scope of influencing the product design during its development phase.

#### 2.5.1.5 Geneva Emotional Wheel (GEW)

The Geneva Emotional Wheel, developed by Scherer (2005), is a theory-based emotional experience self-report tool. In this, the participants are asked to report their emotional experience by rating the intensity of one or more emotions out of twenty distinct emotions arranged in a circular order. Moreover, the options of “no emotion felt” or “other emotion felt” are also provided. McGinn and Kelly (2018) applied the GEW method for measuring perceived emotion on a social robot and found that the technique has great potential for evaluating emotion. The user-friendly graphic design of the tool enables participants to quickly report the felt emotion (Scherer et al.

2013). However, participants may find difficulty in rating the intensity of felt emotion (McGinn and Kelly 2018).

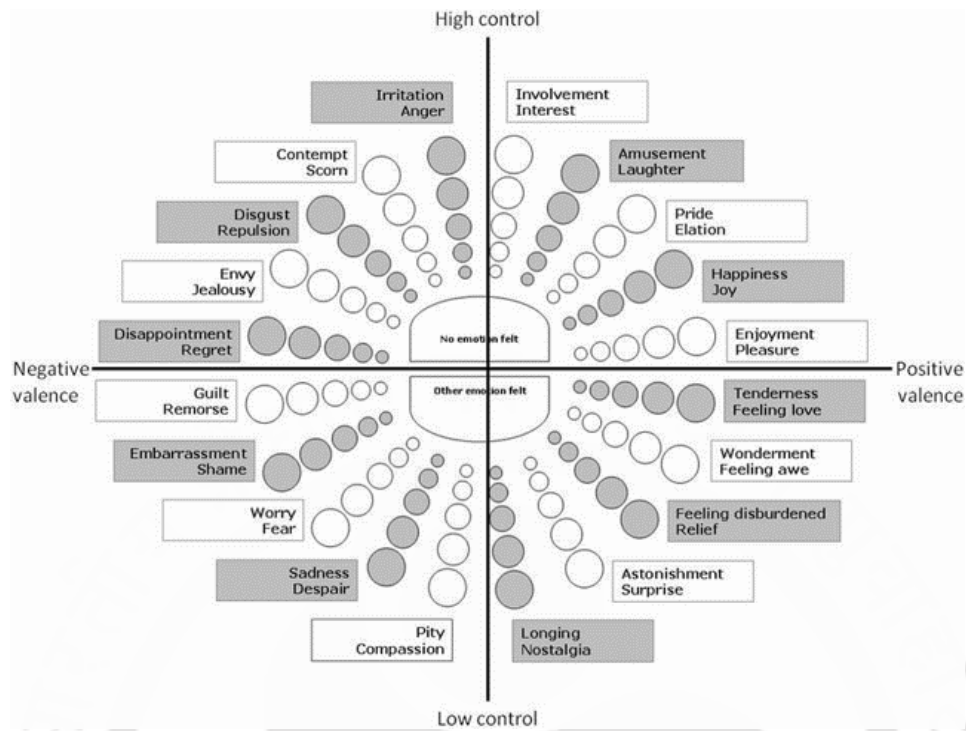


Figure. 2.4: Geneva Emotional Wheel (Source: Scherer, 2005)

Other self-report methods like Conjoint Analysis, Quality Function Deployment, and the Kano model focus on the consumers' explicit needs and aspirations, which can be directly expressed rather than the aspects that are implicit needs like emotional responses (Lokman 2010).

### 2.5.2 Pictorial Self-report

One of the main limitations of the Verbal Self-report methods is that the results of these methods are totally dependent upon the participants' ability to translate the experienced emotions into a verbal rating. However, it might be difficult for some people because they may not relate their emotional experience to the verbal rating scale mentioned in the method. Moreover, such methods are tough to apply in the case of a certain population that is not linguistically sophisticated (Bradley and Lang 1994). Therefore, to avoid the language dependency of the assessment methods, researchers have developed self-report methods that utilize the pictorial representation of the emotions. These methods are grouped in a category called Pictorial Self-report methods. The assessment methods in this category use anthropomorphic visual cues to represent emotions instead of using words. Since the pictorial self-report methods are not word-based, the cognitive process of converting emotional experience into linguistic terms is avoided (Isbister, Höök, and Laaksolahti 2006). Moreover, these methods can be easily adapted for cross-cultural studies (Desmet 2003b).

#### 2.5.2.1 Self-Assessment Manikin (SAM)

The Self-Assessment Manikin (SAM) is an emotional response assessment method that uses a non-verbal pictorial questionnaire. The SAM scale assesses three dimensions of the system of emotion: pleasure, arousal, and dominance (Bradley and Lang 1994). SAM consists of three sets of abstract cartoon characters representing the three dimensions. The first set ranges from smiling, happy character to frowning, sad character for pleasure dimension; the second set of energized, broad-eyed character to drowsy character for arousal dimension and the third set consisting of a change in size (small to large) for dominance dimension. The participants are instructed to rate their reactions to the stimuli on the cartoon character scale.

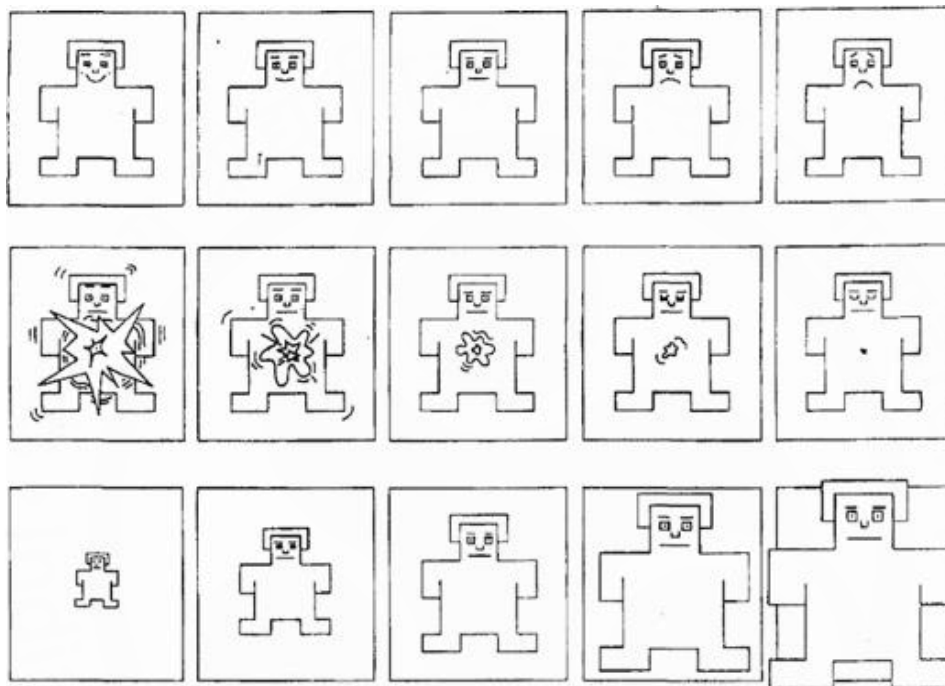


Figure. 2.5: SAM Scale for Rating of Pleasure, Arousal, and Dominance Dimensions of the Emotional System (Source: Bradley and Lang, 1994)

Suk and Irtel (2008) used the SAM rating scale to investigate the emotional response to color stimuli. The use of the SAM scale for the study was seen to help explain the relationship between color and emotions. As the method incorporates a non-verbal technique, it has advantages over a verbal questionnaire, especially in the case of non-English-speaking participants. Moreover, the method seems to be very quick to administer in different settings (Bynion and Feldner 2017). However, this method is often not seen in product evaluation studies because of its inability to measure distinct emotions.

#### 2.5.2.2 PrEmo

Desmet's (2002) "PrEmo" also is a non-verbal pictorial measuring method developed to evaluate 14 emotional reactions to product appearances. In this method, fourteen different emotional states are represented by animated characters, and consumers rate the product appearance by selecting

a particular figure. It is considered the most effective method of measuring emotional response to the product appearance (Demir 2008). It can be used for the measurement of emotions toward new designs and has been well-validated cross-culturally (Laurans and Desmet 2017). Furthermore, the method does not require technical expertise to operate. It can also be used both as a quantitative and a qualitative tool. In some studies, the method has been used to measure emotional response to product interaction as well (Desmet, Porcelijn, and van Dijk 2007). Crippa, Rognoli, and Levi (2012) have employed PrEmo to study the relations between materials and emotions in industrial products.

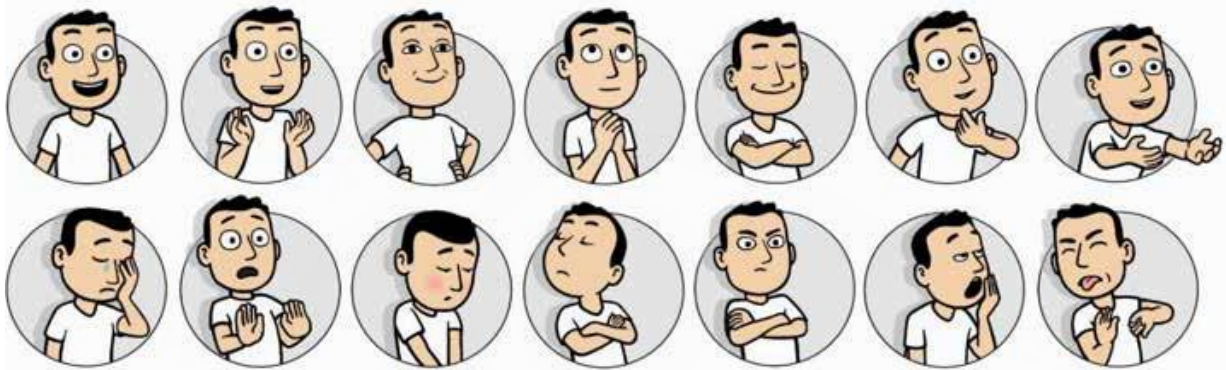


Figure. 2.6: Pictorial Illustrations in PrEmo (Source: Desmet, 2002)

Although the method is seen to be effective in crossing the language constraints, it seems to work well only to identify intense negative emotions and not so effective in the case of determining subtle variations between positive emotions (Schifferstein 2010).

### 2.5.3 Sensorial Self-Report

Consumers examine products through their senses, mainly by sight, touch, hearing, odor, and taste. The process of evaluation is unconsciously happening during their interaction with products. The sensory feedback received by consumers generates emotional responses that are ultimately responsible for shaping purchase decisions. Thus, sensory feedback generated by the characteristics of a product is an essential aspect of design. Therefore, researchers have developed several methods that integrate sensory responses generated during consumer-product interaction to evaluate emotions.

#### 2.5.3.1 Sensorial Quality Assessment Method (SEQUAM)

SEQUAM was developed by Bonapace for FIAT auto with an aim to explore and analyze user-product interactions and generate valuable data for design purposes. The main objective of this method is to establish a link between the physical characteristics of a product and consumers' sensorial responses to them. In this method, consumers evaluate the mock-ups and final product in phases (like visual, tactile and use) and rate their experience using Likert scales. SEQUAM

method has been used by Nicolantonio et al. (2016) for investigating visual pleasantness in interior yacht design. The study showed that the use of SEQUAM provides precise data on users' likes and dislikes linked to the physical parts of the product. The findings of their research also offered guidelines for designers to develop pleasurable products.

### 2.5.3.2 Sensual Evaluation Instrument (SEI)

Isbister, Höök, and Laaksolahti (2006) developed the Sensual Evaluation Instrument (SEI), a self-assessment method that involves the sense of touch for evaluating emotional state. SEI consists of eight physical objects created, taking inspiration from the Disney flour sack, illustrating emotions conveyed by an object. For convenience, the crafted items were assigned names as follows: spiky, pseudopod, anteater, bubbly, stone, doubleball, ball, and barba papa.

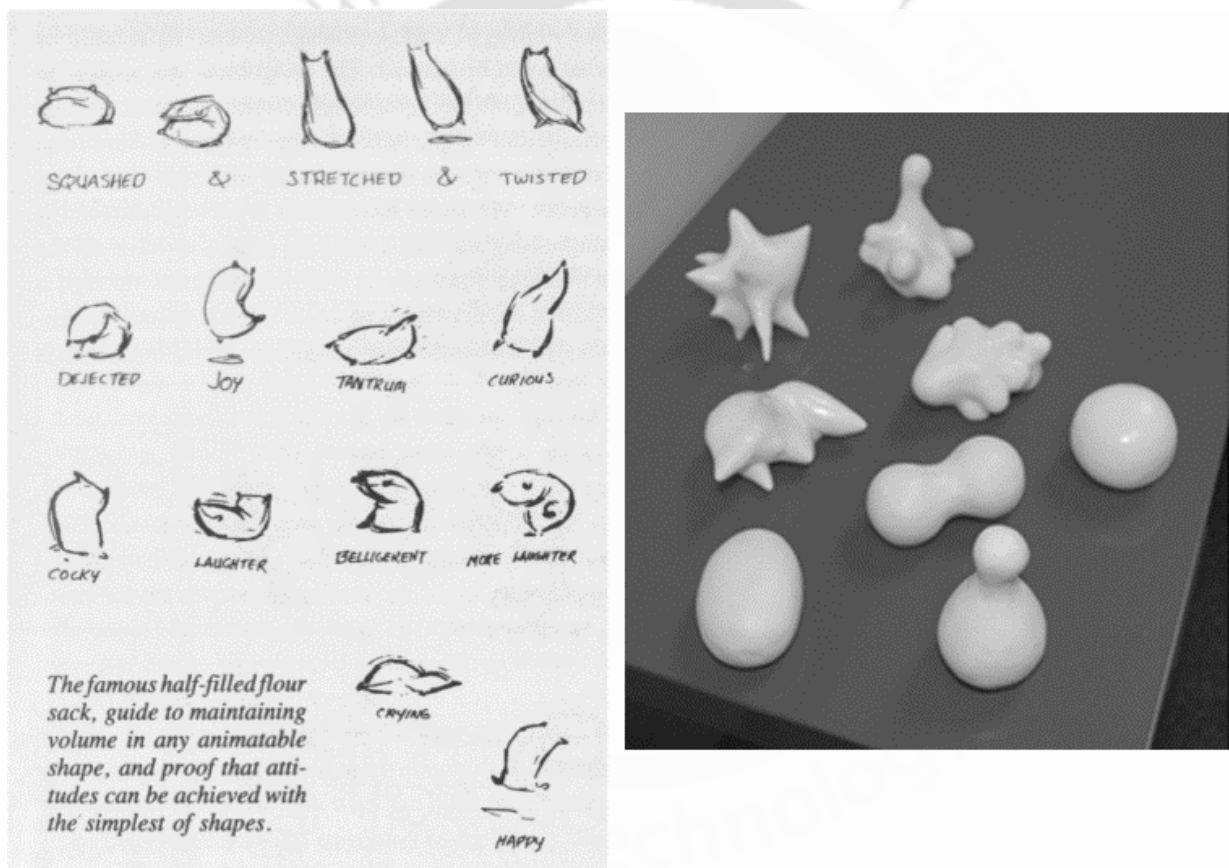


Figure. 2.7: Disney Flour Sack, an Illustration of Emotions Conveyed by an Object (Left) and the Sensual Evaluation Instrument Objects (Right) (Source: Isbister, Höök, and Laaksolahti, 2006)

In SEI experimental setup, the participants interact with a computer system. During their interaction, they are asked to touch the shapes they consider to convey their emotional state. Further, SEI is used to evaluate a computer game following the same process (Isbister et al. 2007). The study revealed that SEI helps designers get a general sense of the emotional state of most participants while playing the game. One of the main advantages of SEI is that it is a non-verbal

method. Hence, it does not depend on the participants' linguistic skills, and it can be easily used for cross-cultural studies. However, SEI does not reveal any particular emotion experienced by a participant. Also, the eight shapes required to conduct SEI cannot be self-made. Furthermore, SEI primarily generates more open-ended qualitative data that needs careful interpretation.

#### 2.5.4 Recall Self-Report

Unlike the emotion assessment methods discussed in the previous sections, Recall Self-report is a memory-based self-report approach developed to avoid biases in a set of questionnaires or predefined pictures inquiring about the emotional state during the consumer-product interaction. In the Recall Self-report approach, consumers are not hindered for recording their emotional state while interacting with a product. Instead, they are probed to report on their emotional state after the consumer-product interaction is over.

##### 2.5.4.1 Relative Subjective Count (RSC)

RSC is an indirect way of assessing consumers' emotional state that compares the variance in the apparent number of interruptions to the actual number of interruptions. This method was developed by Picard and Daily (2005), taking inspiration from the study undertaken by Czerwinski, Horvitz, and Cutrell (2001). In this study, consumers are asked to estimate the time they took to perform a task. The overestimation or underestimation of the time elapsed is then utilized to decide whether the consumers found the task enjoyable or frustrating. On similar lines, in RSC, a specific number of interruptions are planned during a task, and the consumers are asked to estimate the number of interruptions they experienced after the whole task is completed. The estimated number is then compared with the actual number of interruptions. Picard and Liu (2007) proposed that if the estimation is less than the actual number, the task was engaging, and the consumers were in a positive emotional state during the task. On the other hand, if the estimation is more than the actual number, the consumers found difficulties performing the task, and they were in a negative emotional state. Though the RSC method is easy to execute, the outcome generated using this method does not give a clear picture of the specific emotions experienced by a consumer.

##### 2.5.4.2 Cued Recall Debrief (CRD)

Omodei and McLennan (1994) developed the Cued Recall Debrief (CRD) method. In CRD, a video camera is used to record a consumer's actions during his/her interaction with a product. The camera is placed so that the recorded video shows the consumer's point of view. For this purpose, a head-mounted camera is used for dynamic tasks (like moving around while doing an activity), and a screen capture technology is used for static tasks (like performing a computer-based activity). The aim of capturing consumer's point of view is that they can re-immense fully

when the video is replayed in front of them. As soon as the task is completed, the consumer sits down with a debrief facilitator and watches the recorded video. The consumer is then probed to freely articulate his/her thoughts and emotions that occurred during the process. Suppose the facilitator observes any peculiar reactions performed by the consumer in the video; in that case, he/she can pause the video and ask the consumer to elaborate on the thinking and feeling behind those reactions. The facilitator may choose to pause or replay the video to allow the consumer to comment on any specific moment during the process. CRD generates rich qualitative data that must be analyzed carefully to get deeper insights into the overall psychological processes. The main advantage of CRD is that it allows consumers to perform their actions in naturalistic settings without any interruptions during their interaction with a product. However, the data generated through the consumer's articulation of experience needs to be interpreted carefully to gain a greater understanding. Moreover, the outcome depends upon the expertise of the debrief facilitator. Further, the ability to recall the thoughts behind actions performed may differ from person to person.

## **2.6 Physiological Methods**

Physiological methods are a way of assessing emotions by monitoring various human body parameters and changes occurring in them. For the measurement of these parameters and their changes, several biosensors are used. The data recorded by these biosensors are then analyzed to interpret the emotional state of the consumer. One of the main advantages of using physiological methods in assessing emotions is that the consumers do not have to interpret their emotional experience. Moreover, the data required for the assessment of emotions can be recorded without interrupting consumers during their product interaction. The physiological EAMs can be broadly categorized into contact measurement methods and non-contact measurement methods.

### **2.6.1 Electroencephalography (EEG)**

The electrical activities occurring due to the functioning of a human brain are recorded using the EEG technique (Britton et al., 2016). In EEG, a device called electroencephalogram is placed on the human scalp to record the brain signal generated in response to various stimuli. The recorded data is then processed to evaluate the valence and arousal dimensions of emotion. Pedro et al. (2019) utilized the EEG method to analyze consumers' emotional responses to the presentation and use of certain fashion products. Their study found the EEG method to be helpful for the evaluation of emotions.

### **2.6.2 Electrocardiography (ECG)**

The electrocardiography (ECG) method is used to measure heart activity in real-time (Haag

et al. 2004). This heart activity can be used for emotion assessment as the heart is one of the most important organs and central part of the human body system (Goshvarpour, Abbasi, and Goshvarpour 2017). The equipment used for ECG is susceptible to noise and other factors such as the movement of the subject during the procedure. Thus, ECG method can only be applied in highly controlled environments. Moreover, ECG produces a huge amount of data that experts must analyze carefully to decode it in emotional terms.

### 2.6.3 Electromyogram (EMG)

In an electromyogram (EMG), various sensors that measure muscle activity are attached to the skin. Many times, the emotional response is expressed through facial muscle movements (Bartlett et al. 2003). One can draw insights into a consumer's emotional state by measuring these facial activities. Therefore, in most of the EMG research, the focus is on the analysis of facial expressions. The EMG measurement usually takes place in two stages: in the first stage, a baseline is defined, and in the second stage, response to a stimulus is measured. The effect of the stimulus is calculated as a ratio between baseline value and measured value. The main limitation of EMG is that it does not detect low-intensity emotions. However, it is effective in the measurement of strong emotional responses. Moreover, the EMG data analysis is relatively simpler compared to that of EEG and ECG (Dzedzickis, Kaklauskas, and Bučinskas 2020).

### 2.6.4 Galvanic Skin Response (GSR)

The galvanic skin response (GSR) or electrodermal activity (EDA) is used to measure the resistance of the skin. The electrical parameters of human skin vary according to the circumstances without any conscious efforts (Udovičić et al. 2017). Research suggests that the sweat glands of palm skin are sensitive to the change in an emotional state. The sweat glands secrete moisture when they become more active. The amount of salt varies due to sweat secretion, and the electrical resistance of the skin varies (Critchley 2002). The skin electrical resistance increases during a relaxed state while it decreases in arousal (Villarejo, Zapirain, and Zorrilla 2012). The main limitation of GSR is the inability to measure the valence level of emotion. Therefore, GSR is often coupled with another EAM to solve this issue (Dzedzickis, Kaklauskas, and Bučinskas 2020).

### 2.6.5 Respiration Pattern (RSP)

The velocity and depth of respiration of a human changes according to the experienced emotions. Valuable data about the emotional state can be extracted by measuring one's rate of respiration and respiration pattern. Studies have shown that the respiration rate is around 20 times per minute when in a calm state, while it becomes forty to fifty times per minute in excitement (Zhang et al. 2017). Research suggests that deep and rapid respiration often shows excitement, while shallow

and rapid respiration shows tension or fear. Similarly, deep and slow respiration shows a relaxed state, while shallow and slow respiration shows a negative or depressed state of emotion (Kim and André 2008). Unlike EEG or ECG, the RSP method is a non-contact method of measurement as the data can be recorded using a video or thermal camera.

2.6.6 Speech Recognition (SR)

Similar to the RSP method, the speech recognition method is also a non-contact measurement method. The spoken language, depending upon the way of saying, conveys ample information about one’s emotional state (Nicholson, Takahashi, and Nakatsu 1999). Thus, speech recognition (SR) has a lot of potential in emotion assessment. In SR, variations in the vocal cues are analyzed to know about the arousal dimension of emotion. The vocal cues are the pitch of voice and the rate of speaking (Banse and Scherer 1996). Williams and Stevens (1972) suggested that loud pitch and fast pace of speech are associated with positive arousal, while slow rate and low pitch are associated with negative arousal. However, for evaluating the valance dimension of emotion, researchers still have no agreement on the effectiveness of SR method (Liscombe 2007). Nicholson, Takahashi, and Nakatsu (1999) used neural networks to analyze speech and assess emotions. The results obtained in their study confirmed that emotion recognition in speech could be done effectively using neural networks.

2.7 Taxonomy of the EAMs in Product Design

To summarize the review of seventeen EAMs, we propose a taxonomy based on the way of recording emotion-related information. The same is represented in Figure 2.8.

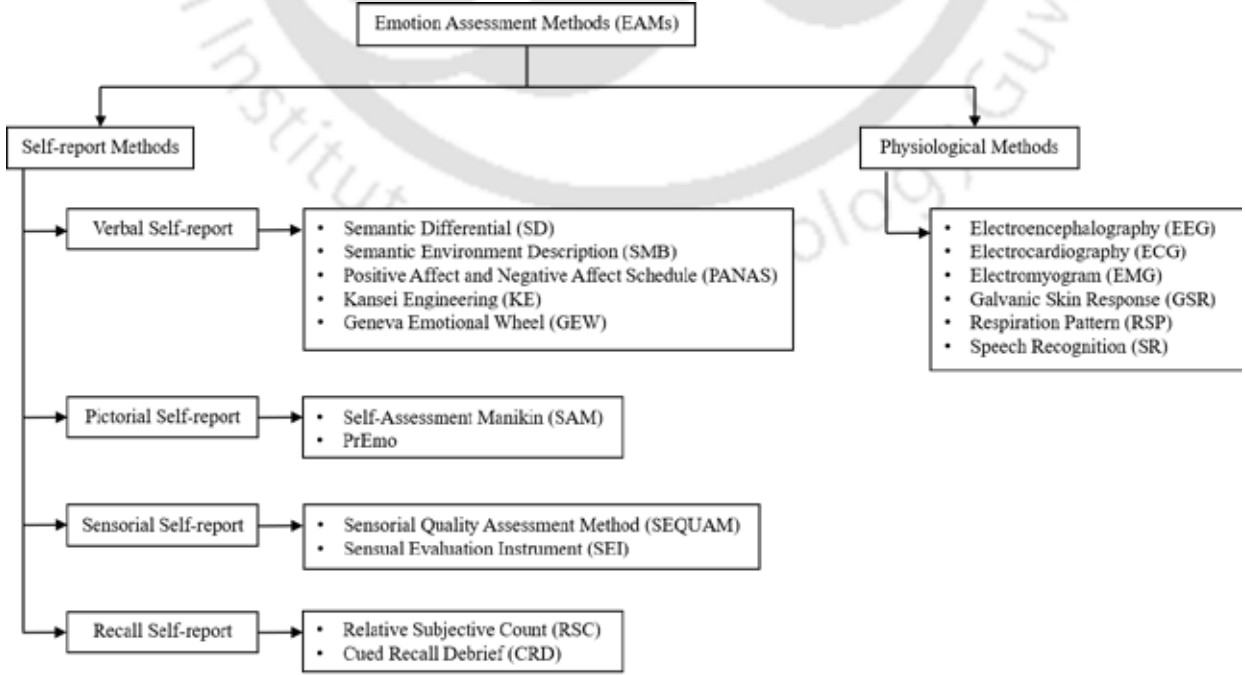


Figure. 2.8: Taxonomy of the EAMs in Product Design

## 2.8 Criteria for Selecting a Suitable EAM

The criteria for selecting a suitable EAM were also identified by way of the review itself. For instance, Laurans and Desmet (2017) stated that PrEmo is suitable for cross-cultural studies. In another study, the SMB method was suggested to be helpful in generating quantitative data (Küller, 1975). Therefore, the factors like “suitability for cross-cultural studies” and “usefulness for generating quantitative data” decided to be some of the selection criteria. All the extracted criteria were organized in the form of eight questions and the measures on which these questions could be answered.

Table. 2.4: Identification Criteria

Sr. No.	Questions	Measures
1	How does the EAM record the emotion-related information?	<ul style="list-style-type: none"> <li>• Self-reported by the participant</li> <li>• Automated detection of participant's physiological parameters</li> </ul>
2	What tools or instruments are required to record the emotion-related information?	<ul style="list-style-type: none"> <li>• Verbal Questionnaire</li> <li>• Pictorial representation of emotions</li> <li>• Physical shapes representing emotions</li> <li>• Biosensors</li> </ul>
3	What is the nature of the data that is generated through the application of EAM?	<ul style="list-style-type: none"> <li>• Qualitative Data</li> <li>• Quantitative Data</li> </ul>
4	What type of products can be evaluated using the EAM?	<ul style="list-style-type: none"> <li>• Product Images</li> <li>• Physical Products</li> <li>• Interactive Products on computer/mobile</li> </ul>
5	What are the resources needed?	<ul style="list-style-type: none"> <li>• Pen and Paper</li> <li>• Computer Software</li> <li>• Special Equipment</li> </ul>
6	When can we employ the EAM in a study?	<ul style="list-style-type: none"> <li>• During the task</li> <li>• After the task</li> </ul>
7	Is the material required to conduct the study using the EAM ____ ?	<ul style="list-style-type: none"> <li>• Available for free</li> <li>• Self-made</li> <li>• Purchased</li> </ul>
8	Can the EAM be directly used in particular circumstances like __?	<ul style="list-style-type: none"> <li>• Cross-cultural studies</li> <li>• Field Studies</li> </ul>

All seventeen EAMs are compared based on the criteria mentioned in Table 2.4. The comparison is represented in the form of a matrix in Figure 2.9.

Method	SD	SMB	PANAS	KE	GEW	SAM	PrEmo	SEQUAM	SEI	RSC	CRD	EEG	ECG	EMG	GSR	RSP	SR
Criteria																	
<b>Measurement Technique</b>																	
Self-report	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Physiological												<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Tools or Instruments required to record the emotion-related information</b>																	
Verbal Questionnaire	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						
Pictorial representation of emotions						<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>										
Physical shapes representing emotions									<input checked="" type="checkbox"/>								
Biosensors												<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Nature of the data generated</b>																	
Quantitative	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Qualitative							<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>						
<b>The type of products that can be evaluated</b>																	
Product Images	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Physical Products	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Interactive Products on computer/mobile	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Resources needed</b>																	
Pen and Paper	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						
Computer Software				<input checked="" type="checkbox"/>													
Special Equipment									<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>At what stage EAM is applied</b>																	
During the task	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
After the task										<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						

Figure. 2.9: Comparison Matrix for the Identification of Useful EAM based on the Research Context

Method	SD	SMB	PANAS	KE	GEW	SAM	PrEmo	SEQUAM	SEI	RSC	CRD	EEG	ECG	EMG	GSR	RSP	SR
<b>Material required to conduct the study can be</b>																	
Available for free			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>											
Self-made	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						
Purchased				<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b>Can the EAM be directly used in special cases like</b>																	
Cross-cultural studies						<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Field studies	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						

Figure 2.9: Comparison Matrix for the Identification of Useful EAM based on the Research Context

## 2.9 Creativity and Assessment of Creativity

Based on the literature survey and the interview sessions with industry professionals (mentioned in section 1.6.2.4 ), it was pretty clear that the process of designing has become more complex than it used to be. The rapid pace of change of technology, innovations in materials, requirements of sizes, shapes, and colors, modern manufacturing methods, quality requirements have all merged and resulted in a multifold increase in the complexity of a designer's job. Moreover, modern consumers consider functionality and usability to be fundamentally existent in the product, and their search has moved towards satisfaction of higher-order needs, i.e., emotional satisfaction. Furthermore, the contemporary design industry (especially start-ups) relies heavily on designers' creative idea generation skills. Although traditional design methods have always assisted designers in dealing with practical situations and challenges, the complication of contemporary design concerns is not paid sufficient attention to in these design methods. This situation provides fresh opportunities to carry out fundamental design research to develop a novel design method that assists designers in maximizing their creative performance and consider emotional aspects during idea generation. In view of the research problem, it was felt relevant to review the researchers' perspective of creativity and adopt the appropriate creativity assessment technique.

### 2.9.1 Creativity

In the most general sense, creativity is an act of generating something new using original and unusual ideas. The phenomenon of creativity may produce intangible or tangible outcomes. A few definitions from the literature describing creativity are reviewed to explore the researchers' perspectives.

### 2.9.2 Definitions of Creativity

Torrance, also known as 'Father of Modern Creativity', defines creativity as "... the process of sensing gaps or disturbing, missing elements; forming ideas or hypotheses concerning them; testing these hypotheses; and communicating the results, possibly modifying and retesting hypotheses" (1962). Torrance also developed a method for quantifying creativity, popularly known as the Torrance Test of Creative Thinking (TTCT), in which creativity is given a score level based on problem-solving ability.

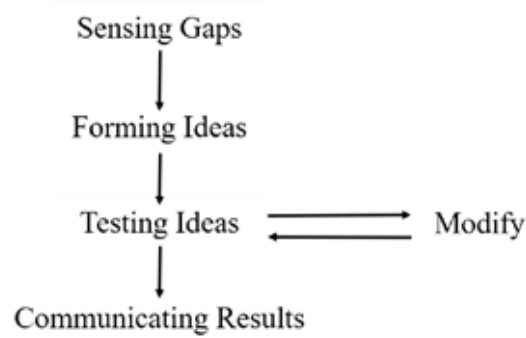


Figure. 2.10: Creativity Process (Source: Torrance, 1962)

Amabile (1983) proposed a Componential Model of Creativity based on three main elements, namely Expertise (domain-specific skills), Creative Thinking Skills (ability to approach a problem imaginatively), and Task Motivation (inner desire to solve a problem). According to this model, an individual's creativity peak is reached when an individual with high domain expertise and high creative thinking skills, working in a supportive environment, is internally motivated to solve a problem.

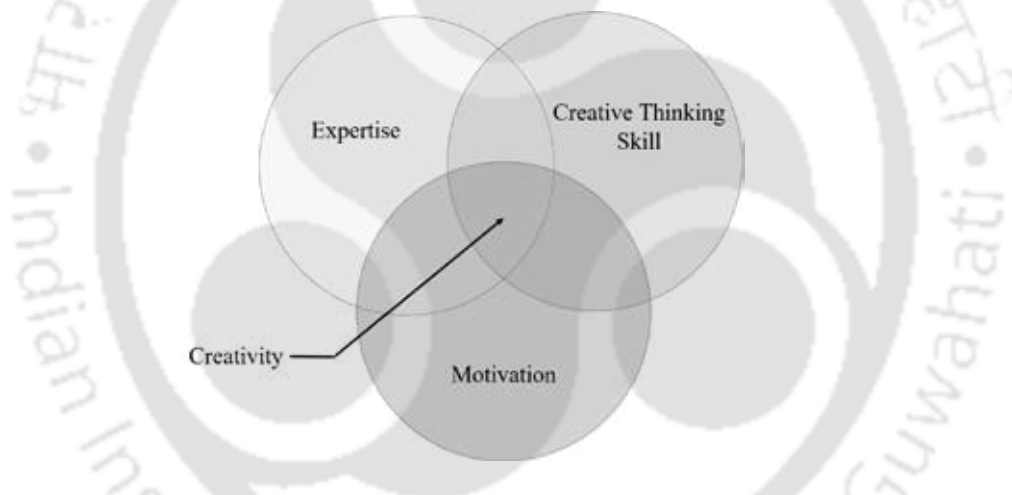


Figure. 2.11: The Three Components of Creativity (Source: Amabile, 1983)

According to Runco and Jaeger (2012), creativity consists of two vital parts, and any one part alone is not adequate for creativity. These two essential parts are originality and effectiveness. Originality is novel, unconventional, unique. Originality is essential but not sufficient for creativity. Original things must be effective to be creative. Effectiveness is usefulness, appropriateness, successful in producing desired results.

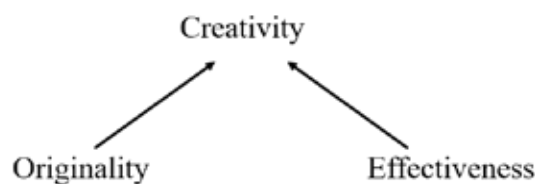


Figure. 2.12: Essential Elements of Creativity (Source: Runco and Jaeger, 2012)

From the above definitions, it can be stated that creativity is the capability to develop an outcome that is novel (original), exemplary and useful (suitable for the context).

## 2.10 Creativity Assessment

A technique known as the Consensual Assessment Technique (CAT), proposed by Amabile (1982), has been called a 'gold standard' of creativity assessment in research (Carson, 2006). The CAT is considered to be a well-validated tool of creativity assessment, and creativity researchers have widely used it. This technique is not connected to any specific theory of creativity; thus, its validity does not depend upon the validity of any theory. Moreover, it is found that the CAT is independent of gender and ethnicity biases (Baer & Mckool, 2009). The basic idea behind CAT is that the evaluation of creativity of work is the joint estimate of experts in that domain.

### 2.10.1 Conducting CAT

The CAT is conducted in two basic feasible steps.

- First, the subjects are asked to create a work.
- Then, domain experts are asked to judge the creativity of the work that the subjects have created.

Unlike many other creativity assessment techniques that evaluate the traits or attributes associated with creativity, the CAT looks directly at the creative outcome that the subjects have produced. Further, the most reliable assessment of creativity of the produced work is the combined evaluation of the experts in that field. The experts rate the work independently and are not influenced by other experts evaluating the same work.

### 2.10.2 Selection of Experts

Amabile (1982, 1996) has recommended criteria for selecting judges for creativity assessment. According to Amabile, judges for the assessment should be 'knowledgeable' individuals of the domain in which subjects have produced their work. However, there is no specific mention of length and type of domain expertise. In literature, various researchers have preferred experts with varying work experience in the domain. For instance, a study conducted by Yuan and Lee (2014) considered experts with at least eight years of experience in product design. In comparison, Daly and colleagues (2016) considered experts with three years of experience in mechanical engineering product design work. Thus, the question remains: how many years of experience in the field can be considered as enough to get expertise? The answer to this is more importance should be given to neutrality and unbiased judgment rather than length of experience (Hennessey, Amabile, Mueller; 2011). If required, little training or guidance could be given to the judges to calibrate their ratings as reported in the study conducted by Friedrich and Mumford (2009), and judges should be asked to rely on their expert sense of what is creative in the domain. Amabile (1996) also mentioned that

the judges should be asked to rate the items comparing them within a sample, rather than based on all the available work in the domain. The judges should not be forced to explain their judgment.

### 2.10.3 Number of Experts

Amabile (1982) has mentioned the dilemma over determining an ideal number of judges for the creativity assessment. In literature, some studies have considered as few as two experts (Daly et al., 2016), while some other studies have gone up to 134 experts (Valgeirsdottir et al., 2015). However, Cseh and Jeffries (2019) argued that increasing the number of judges above 10 increases the risk of Type I error (false positive), and decreasing the number of judges below five would likely cause both Type I and Type II (false negative) error on inter-rater reliability. Kaufman et al. (2008) also proposed that the ideal number of judges should be between 5 to 10.

### 2.10.4 Method of Presentation

If the experts are easily accessible and the number of items to be judged is less, then the creativity assessment sessions can be easily organized. However, the experts are often situated at different locations, and they have limited time due to their busy schedules. Moreover, if the number of items to be judged is more, conducting evaluation sessions becomes tricky. In such circumstances, new digital platforms can be utilized with a preliminary usability test. Furthermore, Amabile (1996) suggested that the number of items to be judged should be in a range that does not cause cognitive overload and can be managed in a limited time to avoid rater fatigue.

### 2.10.5 Rating Factors

Amabile (1982, 1996) had suggested assessing creativity based on two factors, originality and appropriateness to the context. Some researchers have considered additional factors as criteria for judging creativity in the literature. For example, Shah et al. (2003) consider novelty, variety, quantity, and quality. Christiaans and Venselaar (2005) used technical execution and aesthetic appeal as additional factors to be judged during the assessment of creativity. For the present research, the following factors were considered as a measure of creativity. After reviewing several research studies and understanding their suitability for the current context, these factors were chosen.

#### 2.10.5.1 Ideation Quality

The quality of ideas can be measured against the following four factors:

- Novelty: Shah et al. (2003) defined novelty as the unusualness or unexpectedness of an idea when compared to other ideas. In other words, novelty gauges an idea's obviousness, where

non-obvious ideas are considered novel whereas obvious ideas are non-novel. Novel ideas expand the design space and increase the odds of finding fresh, original designs. Thus, the novelty in idea generation is significant.

- **Appropriateness:** It is nothing but the relevance of the idea in the given context. The idea will be effective in producing desired results if it is suitable for the given situation. In the present study, the appropriateness of an idea would be measured based on its aesthetic appeal as the study primarily targets creativity in formal (related to shapes) idea generation.
- **Elaboration:** It is the ability to detail the idea and appropriately label it for clarity. It is measured based on the amount of detailing done for each idea attribute.
- **Surprise:** It is the ability to create something that continues to capture the viewer's eye each time upon revising. An idea having a surprise factor may not be the most novel or original idea, but it may be a combination of obvious ideas in an unexpected way.

#### 2.10.5.2 Ideation Variety

Variety ratings are applicable to an entire group of ideas and not an individual idea. Thus, the measure of variety can be considered for a whole ideation session.

- **Variety:** Variety is measured as the total number of different ideas created by a subject or a group of subjects in an ideation session. For the current research, any two ideas were considered distinct if they differ in their embodiment and details. The measure of variety indicates how well the design space has been explored, and it is directly linked with the ability to restructure the problem.

#### 2.10.6 Rating Scale

Though Amabile (1982) explored a variety of rating scales, it appears that the studies favored a five-point rating scale. In literature, creativity researchers have used rating scales ranging from three to ten points; however, there is little or no justification for why one scale was preferred over another. According to Preston and Colman (2000), the optimum rating scale should have between five and seven points. The present research used a seven point rating scale.

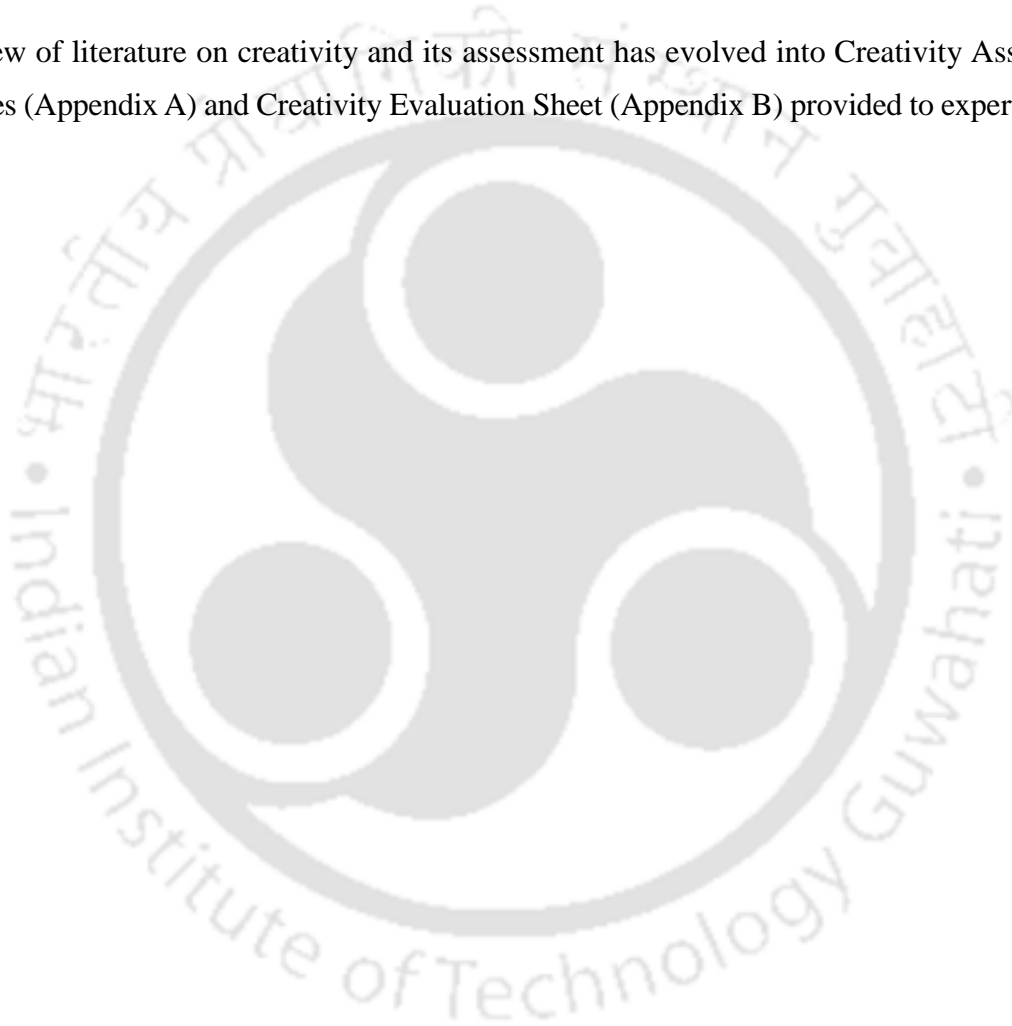
### 2.11 Discussion and Findings

This chapter reviewed the fundamental terminologies in emotion research to understand and develop a perspective exploring relationships between design, emotion, and consumer responses. It involved reviewing and critically analyzing seminal studies, theories, and models previously proposed in this domain (viz. Emotional Design, Appraisal Theory, Pleasure Model, Technology

as Experience Framework, and Product Personality Assignment). Based on the review insights, we enlisted the advantages and limitations of each of the reviewed theories.

The current chapter also presented a comprehensive review of seventeen emotion assessment methods (EAMs). Each of these methods has its own pros and cons, which were also assimilated in the present chapter through an extensive review of the existing literature. Furthermore, we have developed criteria for comparing these methods on eight factors that are manifested in the form of questions and their associated measures. One can examine an EAM on these identified eight factors to choose the best method suited for the context of the undertaken research.

The review of literature on creativity and its assessment has evolved into Creativity Assessment Guidelines (Appendix A) and Creativity Evaluation Sheet (Appendix B) provided to expert judges.



## Chapter 3. Shaping Emotions Framework

### 3.1 Introduction

Initially, problem-solving was typically considered a logical effort. However, over the past few years, it appears that a purely logical and rational approach fails to understand the crux of problem-solving. Creativity is crucial in problem-solving (Haggins, 1994). Haggins describes the Creative Problem Solving (CPS) process as eight-stage activity: analysis of the environment, recognizing a problem, making assumptions, generating alternatives, choosing among alternatives, implementing the chosen solution, and control. Amabile (1983) proposed a five-step model of the creative process shown in Figure 3.1.

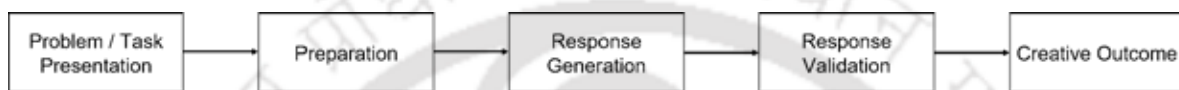


Figure 3.1: Model of Creative Process (Source: Amabile,1983)

- Problem or Task Presentation: Formulation of a specific problem statement.
- Preparation: Recalling information and solution approaches that appear significant to the problem at hand.
- Response Generation: Production of alternative solutions are produced.
- Response Validation: Evaluation of alternative solutions.
- Outcome: Selection of a successful solution. No acceptable solution is found, or a conclusion is drawn that a look back to a previous process step is necessary.

### 3.2 Shaping Emotions Framework

Inspired from the above model, we propose the shaping emotions framework, as shown in figure 3.2. Each modified element is explained in successive sections.

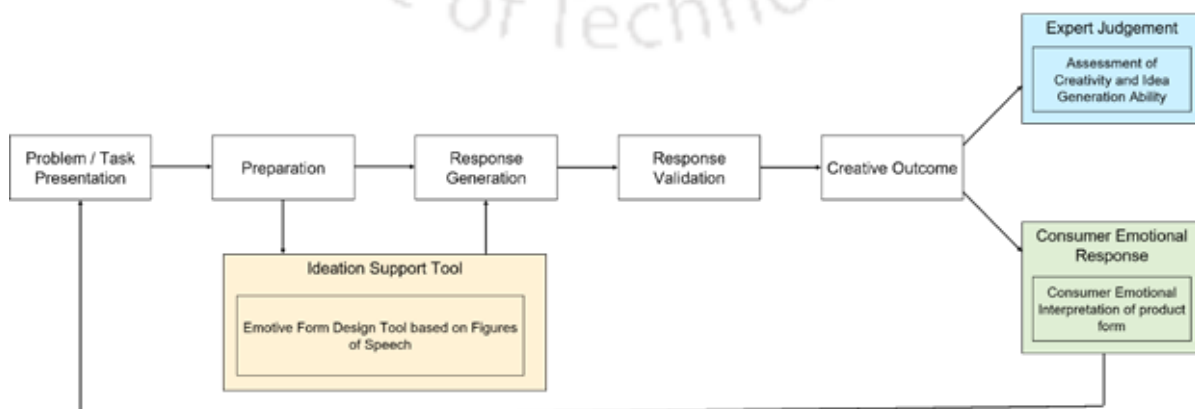


Figure 3.2: Proposed Framework of Shaping Emotions

### 3.2.1 Development of Ideation Support Tool

Prior research in idea generation methods has led to the introduction of several ideation tools and techniques to assist designers in creating new product form ideas. The most widely known and used method, brainstorming (Osborn, 1953), has been thoroughly studied by various design researchers to understand its effectiveness in product form ideation. Although these studies shed light on multiple issues, one inference that can be drawn from them is that the brainstorming method cannot be directly applied for the emotive form ideation for at least three reasons. First, brainstorming for problem-solving activity is designed to be conducted in a group session. Thus the results of the brainstorming sessions hugely rely on the participants' profile and moderator action (Carvalho, 2009). Second, the brainstorming method is more of a general problem-solving technique used in various fields, but it is not designed explicitly for the emotive form generation context. Third, in a typical brainstorming session, participants use words to express ideas, whereas designers rely on sketches to convey their thoughts. These factors indicate a need to study and develop ideation methods for designers, specifically for the emotive form generation context. However, before examining the existing body of knowledge on the specific context of emotive form design, we set our objective of the literature review by laying out the following set of questions.

- What are the existing methods of emotive form design?
- What are the general design principles for such ideation methods?
- What are the goals of and the requirements for these ideation methods?
- What are the pros and cons of these methods?

the following five prominent emotive form ideation methods: (1) Emotion Wheel Approach, (2) Emotive Form Generation Studio Exercise, (3) EmotiveModeler CAD tool, (4) Clay Shaping Exercise, and (5) Biomimicry were reviewed and the same are described in the next section.

#### 3.2.1.1 Emotion Wheel Approach

The emotion wheel approach proposed by Currало (2017) adopts Robert Plutchik's theory of primary emotions. The emotion wheel (figure 3.3) presented by Plutchik (1991) divides human emotions into eight basic or primary categories. These eight primary emotions are joy, trust, fear, surprise, sadness, disgust, anger, and anticipation. All other emotions experienced by humans are combinations of these primary emotions. Currало (2017), in his study, makes use of the secondary emotions described in the emotion wheel. In this method, design students are randomly assigned one of the secondary emotions.

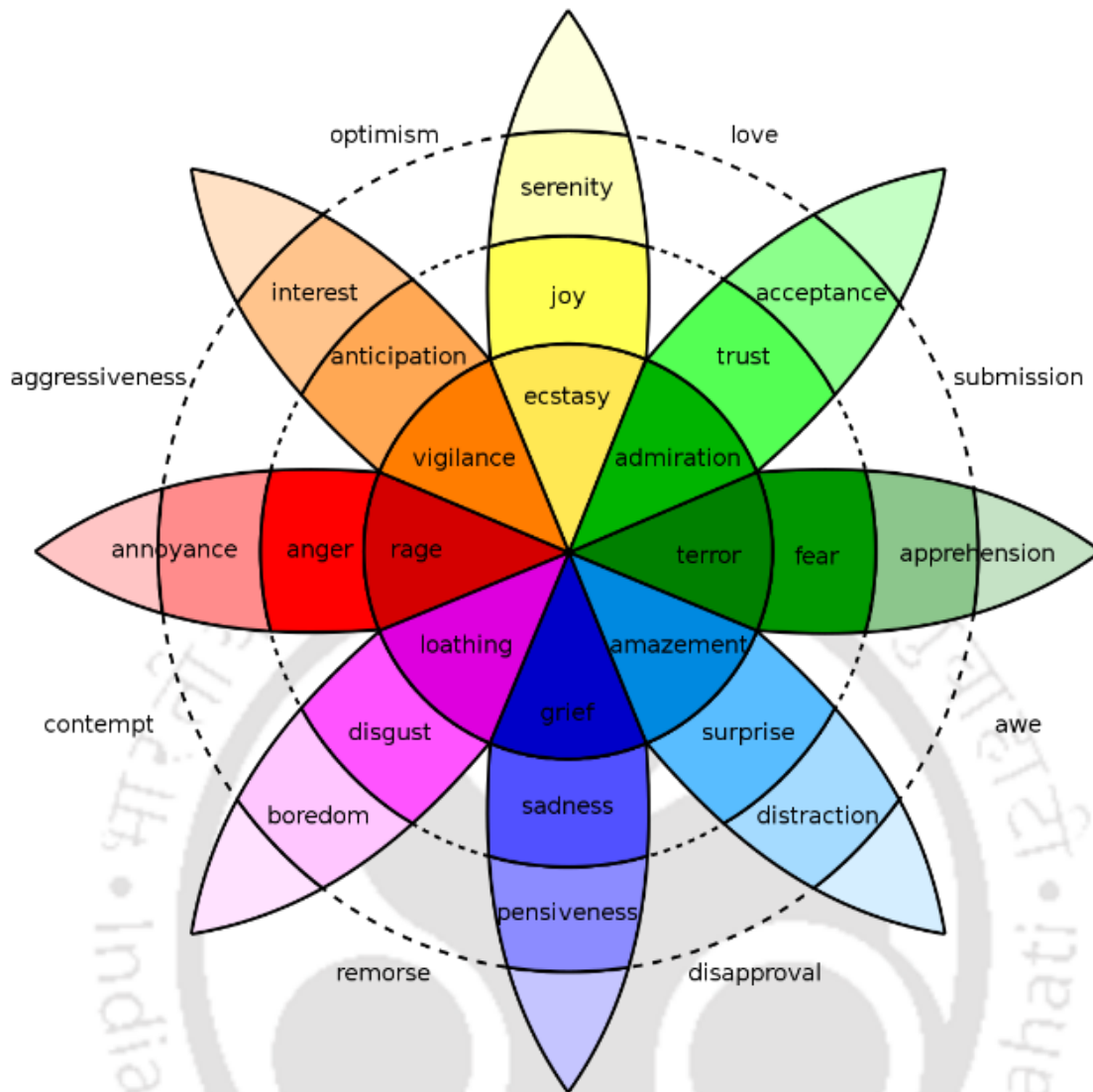


Figure. 3.3: Plutchik's Wheel of Emotion (Source: Plutchik, 1991)

Later, the students are asked to sketch their product concepts based on the assigned emotion and express it through product features. Some of the concepts developed by design students using this method are shown in figure 2. The method proposed by Currallo is easy to use, and it helps stimulate the initial thought process regarding emotive form ideation. However, the forms generated using this method are a too direct and literal representation of assigned emotion. Moreover, the application of this method did not produce completely new ideas.

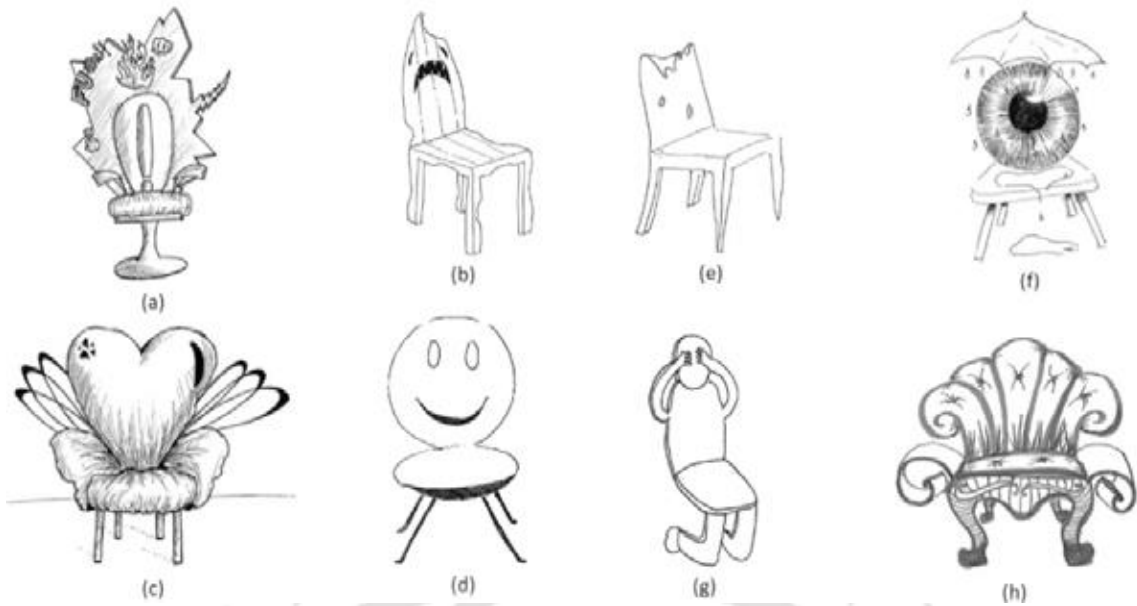


Figure. 3.4: Chair Form Concepts Developed using Curralo's Approach (a) Aggressiveness Chair; (b) Awe Chair; (c) Love Chair; (d) Optimism Chair; (e) Contempt Chair; (f) Disappointment Chair; (g) Remorse Chair; (h) Submission Chair (Source: Curralo, 2017)

### 3.2.1.2 Emotive Form Generation Studio Exercise

This method is a part of an introductory course in product form and aesthetics conducted in IDC School of Design, IIT Bombay (Chakravarthy, 2014). In this method, students are asked to select an emotion of their choice and then collect imagery representing the chosen emotion. Later they are asked to extract elements from the images that are responsible for generating the selected emotion. These elements are then explored into clay models, and the final form is made in PU foam. This method is quite similar to the traditional way of generating product form ideas. As the method involves making physical models of form, tangible interaction with the product forms is possible during the form development process. However, the form outcome depends on the designer's ability to extract elements from the inspiration image. Moreover, a designer adopting this method needs to possess model-making skills as well.

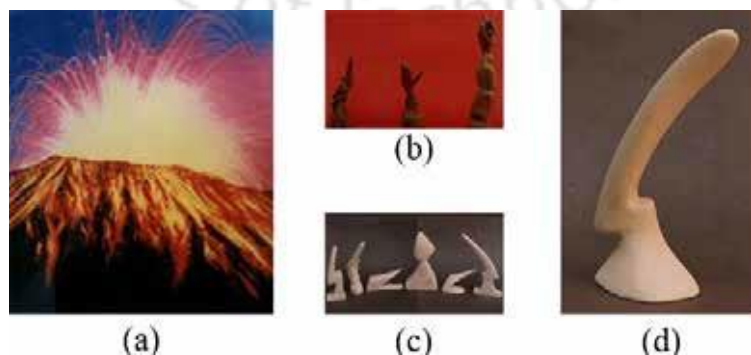


Figure. 3.5: Studio Exercise Method Steps (a) Inspiration Image, (b) Clay Explorations, (c) PU Foam Explorations, (d) Final Form (Source: Chakravarthy, 2014)

### 3.2.1.3 EmotiveModeler CAD tool

The EmotiveModeler CAD tool developed by Mothersill (2014) makes use of 3D modeling software in form ideation. In this method, designers can manipulate the intensity of emotion words on the scale created by the researcher. The CAD tool quickly generates 3D forms based upon the selected emotion intensity. The method is easy to use and quite helpful in developing a lot of form variations quickly. However, the generated forms are dependent upon the software coding previously done by the researcher, and there is little scope for changing this set of rules based on the context. Moreover, form ideas can be created for only a limited set of products predefined in the tool. Further, the method does not test the creativity of a designer.

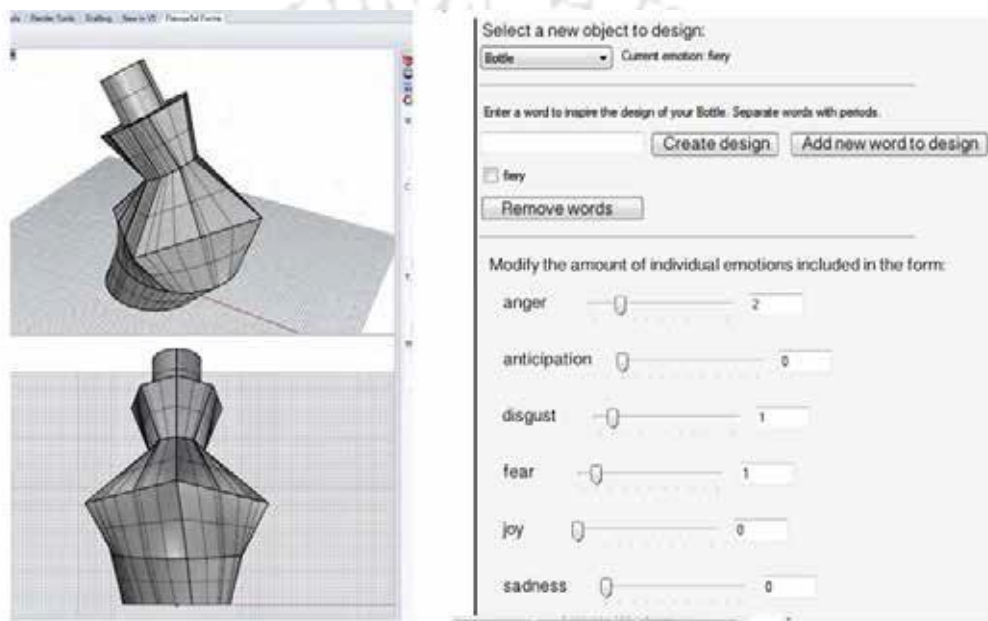


Figure. 3.6: Bottle Form Generated using EmotiveModeler (left) and Software Interface (right) (Source: Mothersill, 2014)

### 3.2.1.4 Clay Shaping Exercise

Clay shaping exercise was proposed by Melcer and Isbister (2016) to generate emotive forms. In this method, Russell's circumplex model (figure 5) of emotion is adopted. The participants are allowed to choose any one emotion, and then they are asked to create a clay shape depicting the selected emotion. They are asked to think aloud while performing the task describing their thoughts, actions, and feelings. In this method, the tactile manipulation of form is possible. However, participants need to have clay model-making skills. In the study conducted by Melcer and Isbister, it was found that Participants pointed out mismatch between their intended form and what had come out at the end of the exercise.

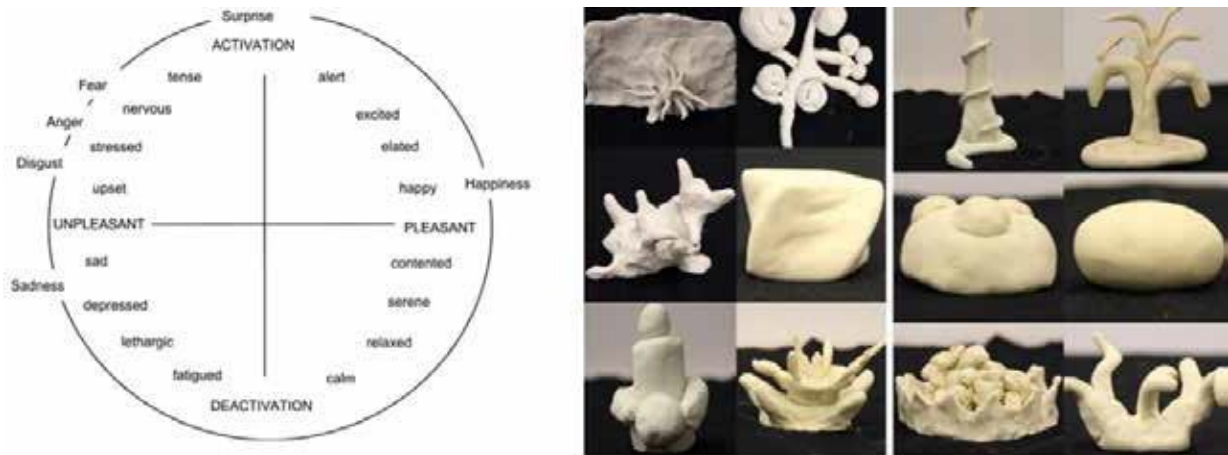


Figure. 3.7: Russell's Circumplex Model (left) and Results of Clay Shaping Exercise (right).  
(Source: Melcer and Isbister, 2016)

### 3.2.1.5 Biomimicry

Biomimicry is a method of mimicking forms, colors, and behaviors from natural life (Janine, 1997) to enhance product quality. Wu and Chen (2015) investigated the emotions elicited in consumers by biomimetic products. The study conducted by Wu and Chen (2015) utilized kitchenware items for the investigation. The kitchenware item forms were modified to create stimuli incorporating three types of biomimetic features, namely, plant features, human contours, and human facial features. Each stimulus had a different level of biomimetic form features ranging from least concrete to very concrete. The study adopted Mehrabian and Russell's (1974) emotional assessment paradigm (pleasure and arousal dimensions) to inspect the consumers' emotions.

Degree of concrete level	Type of Biomimicry		
	Plants	Human contours	Humanoid Faces
L1 Very abstract			
L2 Abstract			
L3 Concrete			
L4 Very concrete			

Figure. 3.8: Stimuli incorporating plant features, human contours, or human facial features.  
(Source: Wu and Chen, 2015)

The study revealed that the use of biomimicry is an effective way of influencing consumers' emotions. Moreover, the study showed that the emotions elicited in consumers by concrete biomimetic features are greater than those evoked by less concrete features. While the study can help designers to develop emotive product forms using biomimicry, it does not guide designers in choosing appropriate inspiration for form ideation. Instead, the designers have complete freedom of randomly selecting any inspiration from natural life. The random selection of inspiration for generating emotive form may result in an unintentional transfer of form features that elicit negative emotions in consumers.

The review of these existing emotive form generation methods revealed that a new ideation method is needed, which assists designers in emotive form generation. Therefore, in the current study, we develop an emotive form ideation technique for product designers. While developing the new method, the following design considerations were taken into account: (1) the new method should be easy to comprehend, (2) it should be easy to use, (3) it should provide a structure way of form ideation, and (4) it should not produce results dependent on additional skills like model-making, knowledge of 3D software.

### 3.2.2 Several Seminal Idea Generation Techniques with their advantages and limitations

Idea generation involves creating a wide range of alternatives, out of which a few can be chosen later on to develop a potential solution. Several tools for creative idea generation have been described in the literature. Haggins presents 70 creativity tools for the same. Kumar (2013), Amabile (1983), Mycoated website have also described more than 50 tools to generate ideas creatively. Out of these tools, the most commonly used and popular tools listed below have been considered to further analyze and compare.

Table. 3.1: Popularly used Creativity Tools for Generating Ideas

Stage of Creativity Process	Creativity Tools
Generating Ideas	Brainstorming, Mind Mapping, Analogies, Attribute Listing, Morphological Analysis, Visual Stimuli, SCAMPER

#### 3.2.2.1 Brainstorming

One of the most widely used design methods for idea generation is brainstorming. Osborn (1953) coined the term 'brainstorming' for a problem-solving activity done in a group. Generally, a brainstorming session is conducted in a small group of people from diverse areas. In brainstorming, a pool of creative ideas is generated by every group member simultaneously to solve a particular problem. This helps to create a large number of ideas quickly. However, Diehl and Strobe (1987), through their study, found that the number of ideas generated in a group brainstorming is far less

than that of an individual working separately. According to Kohn and Smith (2011), the drop in efficiency of group brainstorming is since members may get fixated on the ideas proposed by others in their group. Moreover, individuals may also perceive that the ideas presented by others are superior to their own ideas.

#### 3.2.2.2 Mind Mapping

The Mind Mapping method was first published in 1974 by Tony Buzan and used in 1950 by Allan M. Collin. In this technique, a spider diagram is created representing the connections of topics and sub-topics, a preferred fundamental objective to make an ordered visual representation. The connections represent the associations and affinities of various ideas, areas with the central theme and help to establish new links between them. This technique is a systematic and highly structured approach to creative problem solving, which serves to obtain patterns and recognize hidden opportunities in order to find solutions. However, the literature (Dorst & Cross, 2001) suggests that design problems are often highly unstructured and poorly defined in the initial stages. Thus mind mapping might be more suitable for clearly defined, highly structured problems.

#### 3.2.2.3 Analogies

An analogy is a comparison of two dissimilar things that are shown to have some similarities. In analogy technique, generally, an item in a familiar domain of understanding is compared with a problem situation. This association can be a powerful way to create out-of-the-box ideas. However, designers may not always have appropriate and well-structured prior knowledge of a certain thing associated with the problem situation.

#### 3.2.2.4 Attribute Listing

Attribute Listing is a technique in which the attributes or characteristics of an object, problem, or task are systematically listed down. Further, each listed attribute or a group of attributes is analyzed so that they can be modified and combined in as many ways as possible. Finally, the developed ideas are reviewed, insights are generated for the best possible solution, and suggested alternatives. To summarise, attribute listing is a technique that might be suitable for suggesting improvements or enhancements in the objects or situations to solve a problem.

#### 3.2.2.5 Morphological Analysis

Zwicky (1969) developed the method of morphological analysis. In this method, a product or service to be transformed is selected. Further, a matrix consists of features or attributes of the chosen product or service on one axis and changes in words such as verbs, adjectives, adverbs, etc., on the other axis. A third axis may also be created with some other relevant vital parameters.

Finally, one or more factors on the feature axis are analyzed against the change words and key parameters axes to develop new ideas. The key is to choose elements in such a way that novel insights are discovered in the problem area. Using this method, a number of ideas can be generated in a quick time. Moreover, the process can be done either individually or in a group. However, it is argued that the approach in this technique is too structured, which hampers free, creative thinking. Furthermore, there are no specific guidelines for combining the factors on one axis with those on other axes. Also, these combinations are based on pure judgment, thus prone to errors and weak outcomes.

### 3.2.2.6 Visual Stimuli

Several studies in design have highlighted the importance of the use of visual stimuli in creative idea generation (Hanington, 2003; Muller, 1989; Tovey, 1992). Casakin (2005) and Malaga (2000), in their research, have found out that the use of a collection of images could help to tackle loosely defined problems and stimulate creative ideation. The visual stimuli technique involves forming associations between available images and problem situations. This process triggers the designer's creative thought process and proposes new rich possibilities by putting images and ideas together that are usually unrelated. This tool seems to have the potential to be used for the present study. The only challenge seems to be asking subjects to gather images and make them aware of visual relations through association.

### 3.2.2.7 SCAMPER

SCAMPER is an idea generation technique that stimulates designers' creative thinking by asking them to look at the given product or problem situation through seven different provocative lenses. These seven lenses are Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, Reverse. In this technique, first, a product, service, or problem situation to be improved is taken as a starting point. Then, the designers are asked to go down the list of seven lenses and think about questions regarding each of them. The questions could be as follows:

- Substitute: What else? Different material? Different process? Different features?
- Combine: Unite objectives? Ideas? Uses? Resources?
- Adapt: Other ideas for inspiration? Another purpose?
- Modify: Change shape? Material? Look?
- Put to another use: New use? Somewhere else?
- Eliminate: Remove parts? Features? Rules?

- Reverse: Opposite? Upside down? Swap? Change order?

It is argued that this technique has a limited and narrow focus on specific words of the acronym. Moreover, using this method, only incremental improvements or enhancements might be possible in the existing product or problem situation and might not be helpful to move beyond obvious ideas.

Table. 3.2: Summary of Creative Ideation Tools (advantages and limitations)

Creativity Tool	Advantages	Limitations
Brainstorming	<p>Widely known technique</p> <p>It can be used in a group as well as individually</p> <p>Can generate a large number of ideas in a short span</p>	<p>Group brainstorming might be less efficient than the individual one</p> <p>Collaborative fixation</p> <p>Less number of original and variety of ideas</p>
Mind Mapping	<p>Creates a visual overview of a complex problem situation</p> <p>One can quickly obtain patterns, organize information and focus on the essential things in a problem area</p>	<p>Highly structured technique</p> <p>It can be time-consuming to create a good mind map</p> <p>It may be challenging to apply for a completely new area with no prior information</p>
Analogies	<p>A powerful way to create novel ideas</p> <p>May generate interesting insights that would have never occurred in typical ideation</p>	<p>Needs appropriate prior knowledge of one of the things with which the problem situation is supposed to be shown similarly with</p>
Attribute Listing	<p>A complex problem situation is broken down into parts</p> <p>It might be easier to analyze and explore the problem in parts and subparts</p>	<p>It might only suggest moderately incremental improvements in the existing situation</p>

Creativity Tool	Advantages	Limitations
Morphological Analysis	A large number of ideas can be generated in a quick time  It can be done either in a group or individually	Too structured approach  May hamper free, creative thinking  Prone to errors as it is based on pure judgment
Visual Stimuli	It can be handy to tackle loosely defined problems  Produces novel, original, variety of ideas  Can create a fundamental shift in perspective  Disrupts the system	Might face difficulty in associating problem situations with images
SCAMPER	Ideation may lead towards an entirely new direction  Flexibility in usage	Too narrow focus on a limited set of words related to the acronym  Highly structured approach  Only incremental improvements in the existing situation

To sum up, all the creative idea generation tools examined here are significantly useful for the ideation process. However, none of them can be termed as an ultimate solution. Each one has several pros and cons. Considering the focus of the current study on improving the creative performance of young designers during ideation and design students and novice designers as potential users of the tool in their ideation stage and create ideas that appeal to consumers at the emotional level, the analogy technique seems to be more promising to suit the current research. This tool might need to be modified or combined to form a new tool that can serve the purpose of the present study.

### 3.2.2.8 Design-by-Analogy

An analogy is generally defined as the 'illustration of an idea using another familiar idea that is similar or parallel to it in some significant features' (World of the Body, 2003; Literary Dictionary, 2004). Design-by-analogy is seen as a promising tool for developing innovative design (Leclercq

& Heylighen, 2002; Christensen & Schunn, 2007; Linsey et al., 2009), especially during the ideation phase, where new design ideas take shape. Linsey et al. (2009) claimed that analogy is a comparison between two domains that generate new connections and encourage building fresh insights. Designers can tap this to produce creative designs. The design of the VW Beetle automobile form and George Mestral's invention of Velcro are some of the most cited examples of Design-by-analogy.

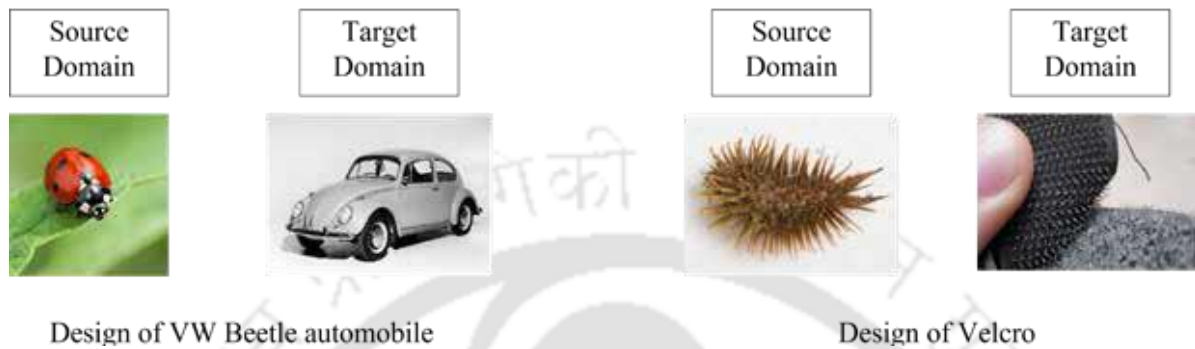


Figure. 3.9: Examples of Design-by-Analogy

The design community has already realized the power of design-by-analogy, and various methods have been developed to use analogy within the design process. Some of the examples of such methods include Synectics (Gordon, 1961) – use of four types of analogies to solve problems: personal (be the problem), direct (functional or natural), symbolic and fantasy analogy; inspiration from nature (French, 1988); Biomimetic Concept Generation (Hacco & Shu, 2002) – methods utilizing biological phenomenon for concept generation; the WorldTree method – (Linsey et al., 2008) – a search for hypernym and troponym for analogies; the Functional and Flow basis (Hirtz et al., 2002) – similar and dissimilar product function and process exploration. These methods have been used with some success. Limitations of each method are listed in the table below.

Table. 3.3: Methods for Design-by-Analogy and their limitations

Method	Working	Limitations
Synectics (Gordon, 1961)	use of four types of analogies to solve problems  personal (be the problem), direct (functional or natural), symbolic, and fantasy analogy  Performed in groups	Much effort is required to keep the focus of the group discussion on the task at hand to get the desired outcome

Method	Working	Limitations
Inspiration from nature (French, 1988) Biomimetic Concept Generation (Hacco & Shu, 2002)	methods utilize biological phenomenon, examples from nature for concept generation	restrictive sometimes as inspirations are drawn only from the natural world
the WorldTree method (Linsey et al., 2008)	a search for hypernym and troponym for analogies	Difficulty in finding the correct category and generalized verb describing the form/function
Functional and Flow basis (Hirtz et al., 2002)	creating abstracted functional models of concepts and comparing the similarities between their functionality	Related more to the functionality rather than form

Moreover, it has been found that analogous design sometimes has a restrictive effect in idea generation (less number of different ideas are generated) (Smith et al., 1993), and even unintentional transfer of negative design features may occur (Janson & Smith, 1991). Therefore, it is essential to choose analogies wisely in order to avoid hindering effects in innovative design ideation. All the above methods keep the designer in charge of selecting analogies that may not always be beneficial as finding relevant analogies is often difficult. Instead of selecting analogies randomly, we propose a method to systematically select analogies. The proposed method takes inspiration from Figures of Speech in the English language.

### 3.2.3 Proposed Emotive Form Design Tool using the Principle of Design-by-Analogy

Osborn (1953) suggested that the innovative solution emerges on breaking out of a conventional pattern, either perceptual or cognitive, which unlocks the way for a broader range of alternatives. The mind works on a pattern that leads to solving a problem under the influence of prior knowledge and may affect creativity. Therefore, we propose a unique method of ideating product forms that uses figures of speech in the English language. Though there are several Figures of Speech in English, it was found that only six of those irony, hyperbole, zoomorphic, chiasmus, alliteration, and simile, could be associated with product forms. The same is explained below with examples.

Table. 3.4: Use of Design-by-Analogy to Develop a New Form Ideation Method

Source Domain	Target Domain
Figures of Speech in English	Product Form Design

Source Domain	Target Domain
Irony Hyperbole Zoomorphism Chiasmus Alliteration Simile	Examples of Existing products for each Figure of Speech

The selected six Figures of Speech are conceptualized in a way to fit into the context of product form design. The idea is to keep the essence of each Figure of Speech intact while molding it for use in the form design context

Table. 3.5: Figures of Speech in English and their Meaning in the Current Context

Figures of Speech	Contextual Meaning
Irony	Form Incongruity
Hyperbole	Form Exaggeration
Zoomorphism	Animal/human-like Form
Chiasmus	Reverse Form
Alliteration	Form Repetition
Simile	Comparison of common characteristics (related to form/function)

### 3.2.3.1 Irony – Form Incongruity

Contextual Definition: Inconsistency between what is anticipated or envisioned and what really happens in terms of form.



Figure. 3.10: Irony Examples (a) Cyclehoop Car-shaped Bike Rack, (b) Plopp Stool, (c) Toga Chair

In example (a), parking is meant for bicycles; however, it has been intentionally given a form of a car. Similarly, in example (b), Plopp Stool, the form gives an impression of inflatable material, but it is actually made up of steel. In example (c), Toga Chair, it appears as if a cloth is hanging on a wooden chair frame; however, one can actually sit on that chair.

### 3.2.3.2 Hyperbole – Form Exaggeration

Contextual Definition: Recognizable and intended exaggeration of an object beyond its typical form.

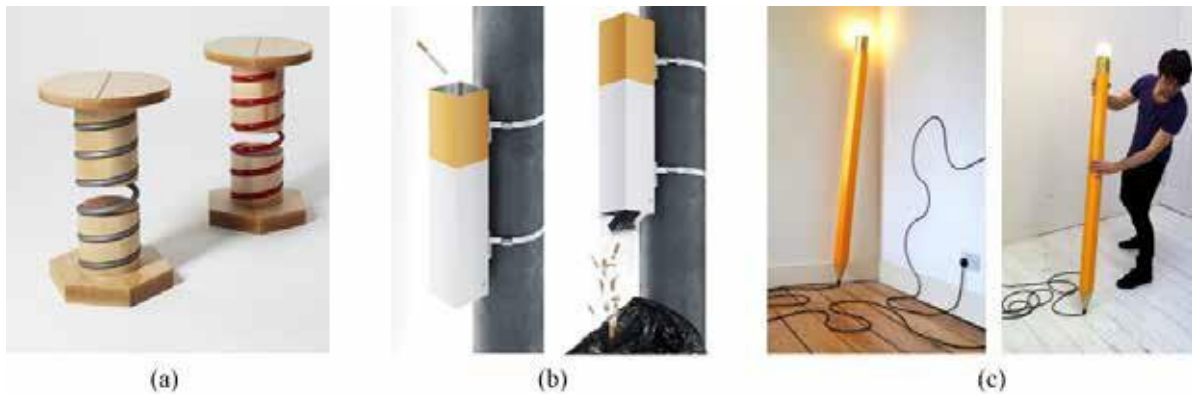


Figure. 3.11: Hyperbole Examples (a) Spring Stool, (b) Pepelkus Outdoor Cigarette Receptacle, (c) Pencil Lamp

Here, everyday mundane objects are internationally exaggerated beyond their standard form. In example (a), Spring Stool, the forms of screw, nut, and spring are excessively amplified. Similarly, form exaggeration is the principle in examples (b) and (c).

### 3.2.3.3 Zoomorphism – Animal/human-like Form

Contextual Definition: Giving an object animal/human-like formal qualities or traits.

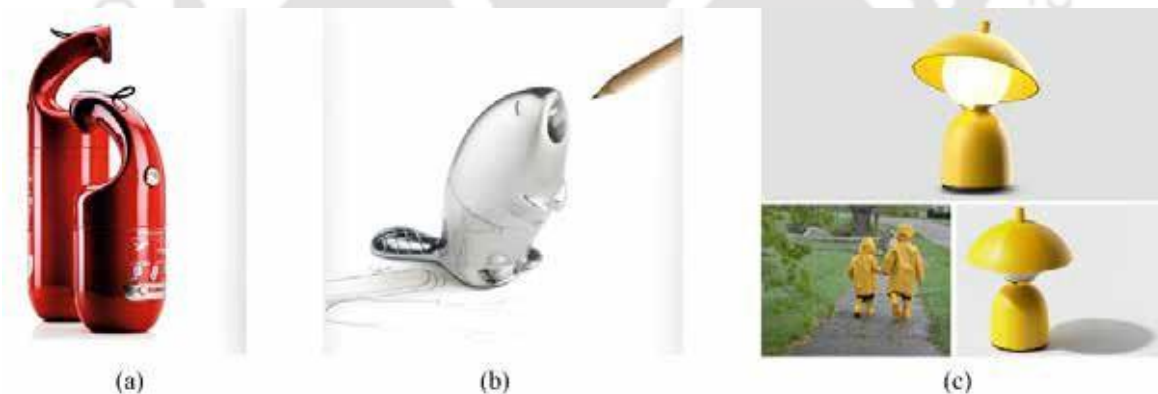


Figure. 3.12: Zoomorphism Examples (a) Firephant, (b) Kastor Sharpener, (c) WooBi Lamp  
In all the three examples (a), (b), and (c), shown in figure 3.12, the forms are inspired by animal or human forms. In example (a), Firephant, the form of a fire extinguisher, is inspired by form of an elephant. In example (b), Kastor Sharpener, the form is driven from form of a beaver animal. Similarly, in example (c), WooBi Lamp, form of children playing in the rain, has an influence on the lamp design.

### 3.2.3.4 Chiasmus – Reverse Form

Contextual Definition: Formal features are arranged in reverse/upside down/inside out.

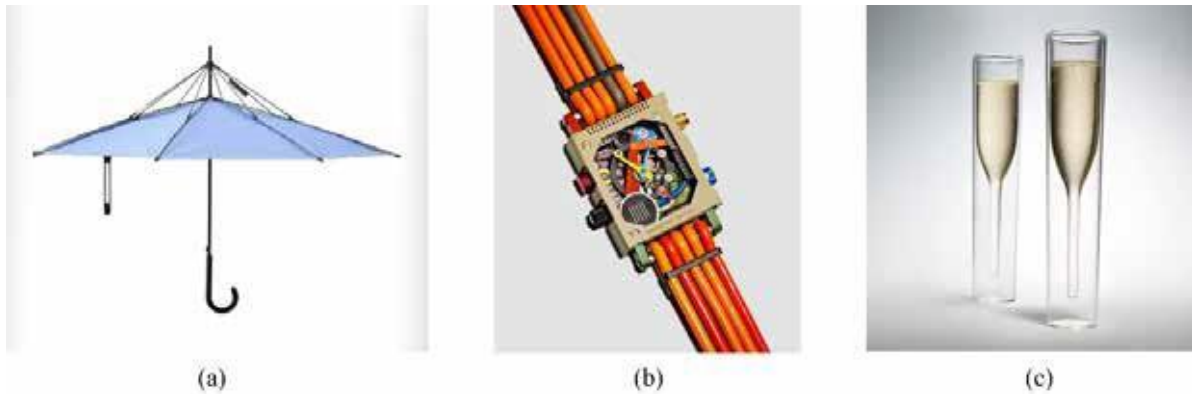


Figure. 3.13: Chiasmus Examples (a) UnBrella, (b) Garbage Watch, (c) Inside Out Champagne Glasses

In example (a), UnBrella, the structure of a typical umbrella is reversed. Similarly, in example (b), Garbage Watch, the internals of a wristwatch are intentionally made visible. In example (c), the Champagne Glasses are designed as inside out.

### 3.2.3.5 Alliteration – Form Repetition

Contextual Definition: Repeating the same or similar form module to create the whole object.

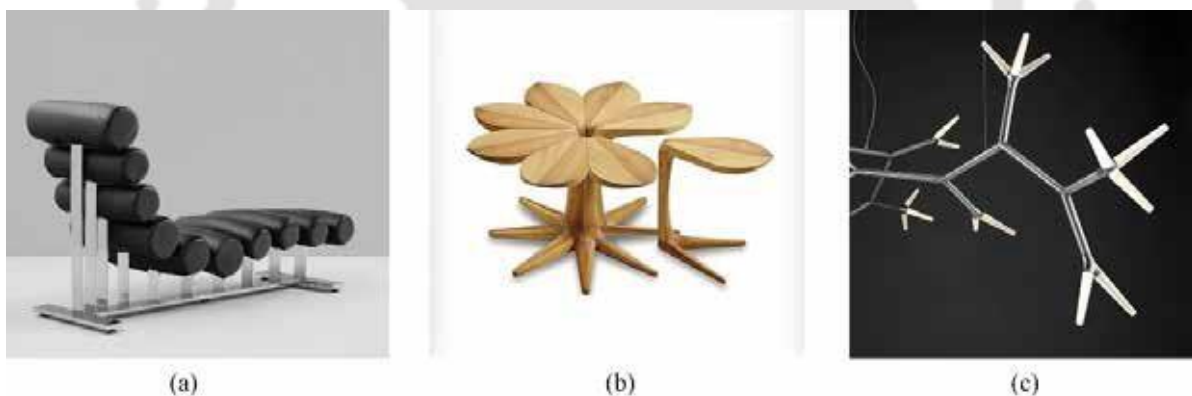


Figure. 3.14: Alliteration Examples (a) Chaise Lounge, (b) Love Me Love Me Not Table, (c) Sparks Pendant Lighting System

In all alliteration examples shown in figure 3.14, one or two same elements are repeated multiple times to arrive at the overall product form. In example (a), the cylindrical seat cushion part and the vertical support are the common elements that are repeated multiple times. In example (b), the petal shaped feature is repeated to form a table. Similarly, in example (c), a tree branch-like structure is created by repeating conical lights.

### 3.2.3.6 Simile – Comparison of common characteristics (related to form/function)

Contextual Definition: Comparing forms of two objects which have one or more common characteristics.

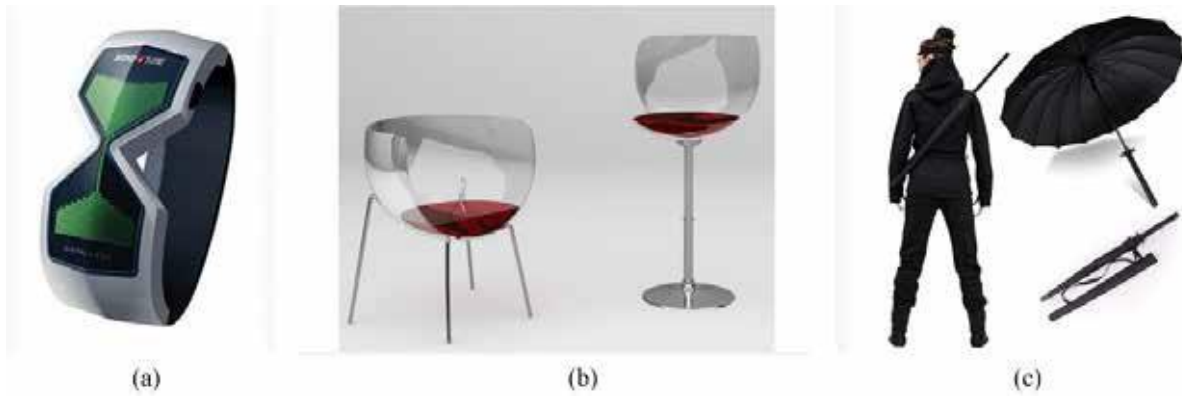


Figure. 3.15: Simile Examples (a) Digital Hourglass Watch, (b) Wineglass Chair, (c) Samurai Umbrella

In example (a), the common characteristic is the measurement of time. The form of a typical sand clock is given to a digital wristwatch based on this common characteristic. In example (b), the principle is holding something stably, holding a drink in a wine glass, and holding a person on a piece of furniture. In example (c), the common theme between the two products is protection—Samurai Sword for protection against enemies and umbrella for the protection against rain.

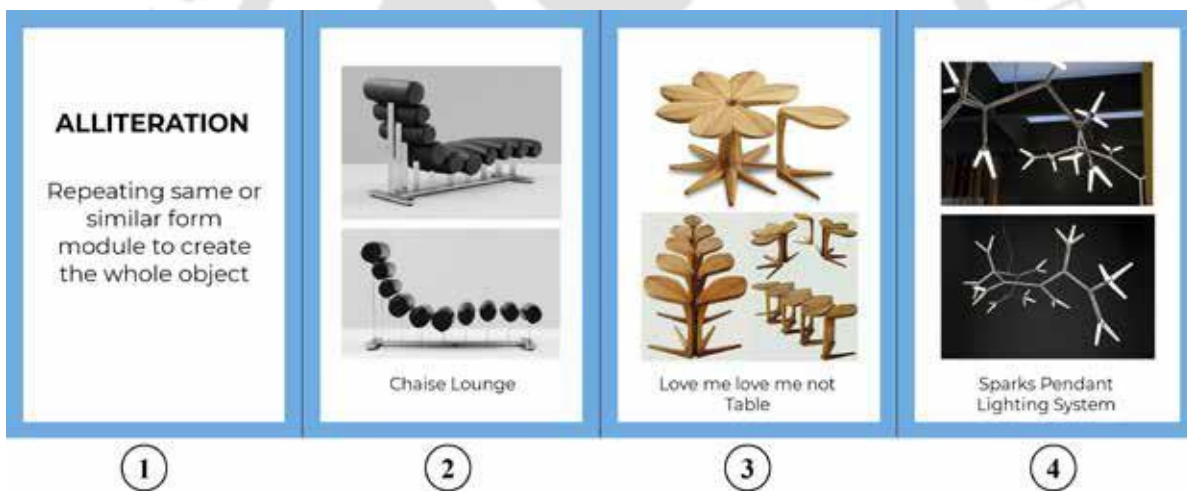


Figure. 3.16: Alliteration Card

The emotive form design method devised using Figures of Speech in English is developed in a card-based tool called Figures of Speech (FoS) Card Tool (Appendix-E). The reason behind making it a card tool is that the card tools are simple to understand and easy to manipulate. Physical cards make the design process visible and less abstract (Lucero & Arrasvuori, 2013; Lafrenière, Dayton, & Muller, 1999). Moreover, they serve as a tool to communicate while designing in a team. In FoS Card Tool, there are six cards, one for each selected figure of speech. The cards are color-coded so that they can be easily distinguished from each other. Further, each card has four parts (shown in figure 3.16). Part (1) has the figure of speech and its contextual definition. The following parts (2), (3), and (4) have images of existing products that fit into the contextual meaning of the figure of speech. Moreover, the names of each product are written below its image. Though there are

several types of card-based tools used in product design, none of the existing ones focus on emotive form ideation. Furthermore, none of the existing card-based tools use figures of speech in product form ideation.

### 3.3 Design for Interest

The present study explores possibilities to design product forms that evoke consumer ‘interest’, a specific positive emotion. The emotion ‘interest’ has been decided to be appropriate for the current study based on the following rationale:

- Several seminal studies in emotion psychology (Plutchik, 1980; Schere, 2005) argued that ‘interest’ has all the attributes to be characterized as an emotion.
- Interest emotion is often observed during product experience (Desmet, 2002).
- Interest motivates people to try out new, unfamiliar things (Silvia, 2008).
- Interest motivates engagement (Renninger et al., 2015), and our ultimate aim is also to initiate consumer-product engagement through product form.

The study investigates prior work from emotion psychology to discuss the conditions for eliciting interest and conceptualize and operationalize ‘interest’ emotion so that a clear, concise definition of ‘interest’ is formed for the current context of product design.

#### Conceptualization and Operationalization of Interest Emotion

The literature is reviewed to seek answers to the following queries:

- What is the ‘interest’ emotion?
- What makes something ‘interesting’?

Several research studies describe interest as a primary emotion (Izard, 2007; Silvia, 2008; Tomkin, 1962). According to Izard (1977), interest is often experienced by humans in day-to-day life. The interest emotion drives curiosity, exploration, and discovery (Silvia, 2012). Interest motivates people to engage in things that are new, unique or unknown. Although sometimes unfamiliar things can be terrifying; people experience them to learn something new. The simple fact of knowing or learning a new thing gives them pleasure. Furthermore, the effect of interest is engagement and exploration. People will explore and think about the new and intriguing thing, be it an interesting object, person, or idea.

The definition of interest emotion evolved through the literature for the current context as ‘an emotional state when you encounter something new and fascinating that you do not understand

immediately. You engage with that interesting object, spend more time in understanding and processing it.’

Research studies claim that the characteristics of novelty, complexity, unfamiliarity and unexpected nature of things are some of the key contributors to evoke interest (Berlyne, 1960; Hidi & Renninger, 2006; Silvia, 2008). Silvia (2005) proposed that the interest emotion has two key attributes: novelty-complexity and coping potential. Novelty complexity deals with the new, unexpected, complex, mysterious, and hard nature of the stimuli, whereas coping-potential is associated with the sufficient knowledge and skill one possesses to deal or operate with the stimuli. Silvia’s approach was adopted for the current study as it explains the underlying principles of interest emotion. However, the current study does not involve any physical interaction with the stimuli. Thus, the component of coping-potential is not applicable in the present context. In another study, Hasio and Chen (2006), demonstrated that the fundamental dimensions of emotional response to product shapes include trend factor (T), complexity factor (C), and potency factor (P). The complexity factor in this study by Hasio and Chen (2006) is similar to the novelty-complexity dimension discussed by Silvia (2005). Moreover, the potency factor (P) is similar to the coping-potential mentioned by Silvia. Therefore, the third factor that is trend factor (T) or trendiness is considered to be relevant attribute for the current research context. Trendiness is the degree of determining whether the form is traditional or modern. Thus, the key attributes constituting in eliciting interest through product form are Novelty (N), Complexity (C), and Trendiness (T). Our intent is to investigate these three factors representing interest.

The studies investigating the relationship between product form and emotional response have used variety of emotional assessment methods (EAMs) for a wide range of products and assessment conditions. The current study uses ‘the comparison matrix for identification of useful EAM based on research context’ (Vaidya & Kalita, 2021) to identify a suitable method. Semantic Differential (SD) method is found to be relevant for the current study on the basis of the comparison matrix. The SD method consists of a questionnaire that asks participants to rate an entity on a multi-point rating scale. The scale has bipolar adjectives at either end of it. Many studies have used SD method for their own set of adjective pairs based on the research requirements. The adjective pairs used for the current study for each indicator are as mentioned in the table 3.6.

Table. 3.6: Indicators and Associated Adjective Pairs

Indicator	Adjective Pair
Novelty	Typical-Unique
Complexity	Simple-Complex
Trendiness	Traditional-Modern

A set of experiments were planned to validate the proposed shaping emotions framework with a

fourth-year undergraduate class and a first-year post-graduate class of product design. The design of experiments for testing the framework and validation through statistical analysis is presented in Chapter 4.

### **3.4 Discussion and Findings**

The FoS card tool developed in the current study and described in this chapter is a structured approach for emotive product form ideation. The proposed tool is devised based on the principle of Design-by-Analogy, in which the source of inspiration (source domain) is six Figures of Speech in English and the target domain is the product form design. The developed technique is a card-based tool representing the contextual meaning of each of the six Figures of Speech and existing product design examples associated with them. The FoS cards work as a source of inspiration representing textual and visual cues for emotive form ideation.



## Chapter 4. Validation of the Proposed Framework

### 4.1 Introduction

This chapter aims to present the results of the statistical analysis of the quantitative data gathered from this research. First, the data was analyzed for the treatment and design-specific agreement between the consumers' ratings and the designer's ratings for the interest emotion attributes of Novelty, Complexity, and Trendiness. This was done to answer the third research question and test the hypothesis that claims there is no significant effect of the Figures of Speech (FoS) card tool on the congruity of interest attributes' rating of a concept by consumers and the same by the designer. Secondly, the data were analyzed for the effect of the intervention on idea generation ability and creativity of designers. This was done to answer research questions 1 and 2.

### 4.2 Planning of Experiments

A set of experiments was planned to answer the third research question associated with the treatment and design-specific agreement between the consumers' rating and the designer's ratings for the interest emotion attributes of Novelty, Complexity, and Trendiness. Two experiment sessions (session duration 3 hours each) were planned as part of the research experiments, with a gap of 4 weeks between the sessions. In the first experiment session, the participants ideated without the support of the FoS card tool (Treatment 1), while in the second experiment session, the same participants ideated with the FoS card tool (Treatment 1). In both the experiment sessions, the participants were asked to design form of a portable/Bluetooth speaker that would evoke interest emotion in the consumers. The rationale behind the choice of a portable/Bluetooth speaker as a test product is explained in the subsequent section.

One hundred seven students from the Department of Design, IIT Guwahati, and National Institute of Design, MP participated in the experiment session (75 students from the fourth-year undergraduate class of Bachelor of Design and 32 students from the first-year postgraduate class of Master of Design). The final concepts generated during both the experiment sessions were screened in two stages. A team of three research scholars at IIT Guwahati screened the concepts based on the criteria mentioned below.

In the first stage, the concepts were screened using inclusion criteria: (a) participated and developed concepts in both the sessions, (b) complete concept sketch, (c) interest attribute rating on the concept sketch. In the second stage of screening, each concept is shortlisted based on the criteria: (a) Originality – the concept is different from existing, (b) Workability – the concept can move from ideation to prototype, (c) Elaboration - level of detail, and (d) Relevance – the concept relevant to the current research context.

The team of three research scholars discussed each concept and screened it using the criteria mentioned above, and 28 concepts (from 14 participants) remained after the screening.

The same 28 concepts were then converted into 3D CAD models and rendered in grayscale. The rendered images were then shown to 34 consumers in an online survey. Consumers then rated each concept on the interest emotion attributes of Novelty, Complexity, and Trendiness on a seven-point semantic differential scale. The purpose of converting sketches into CAD models was to avoid bias in the consumer rating due to the sketching quality. These 28 concept sketches along with the associated 3D rendered model, are included in Appendix – D.



Figure. 4.1: Ideation Session with Design Students

To answer research questions 1 and 2, five experts then rated the same 28 concepts for creativity and idea generation ability assessment. The factors considered for this rating are mentioned in Appendix – A and the details of expert evaluators are mentioned in Appendix - C.

**4.3 Choice of Test Product**

Industrial design encompasses many product categories like furniture, home appliances, toys, automobiles, and so on. We decided to focus on mass mass-produced, small electronic devices and home appliances in the current study. An online survey was conducted among Indian youth (age 18 to 29) (Youth in India, 2017) to determine the most used or most purchased electronic devices/home appliances by Indian Youth. In the survey, 86 participants from 11 major cities in India recorded their responses. The responses were collected on a list of the 20 most commonly used electronic devices mentioned in the table.

Table. 4.1: Most commonly used electronic devices

Electric Iron	Electric Kettle
Table Lamp	Trimmer
Mixer Grinder	Microwave Oven
Bluetooth Speaker	Room Heater

Hair Dryer	Table Fan
Water Purifier	Coffee Maker
Digital Camera	Air Purifier
Pen Drive	Hand Blender
Water Heater	Pop-up Toaster
Laptop	Television

The analysis of the survey data showed that the following three are the most used or most purchased electronic devices/home appliances by Indian Youth.

- Pen Drive
- Laptop
- Bluetooth Speaker

Out of the three devices mentioned above, Bluetooth Speaker appears to be the object where the exercise of form design would show exciting results. Therefore, Bluetooth Speaker was decided to be the choice of the test product.

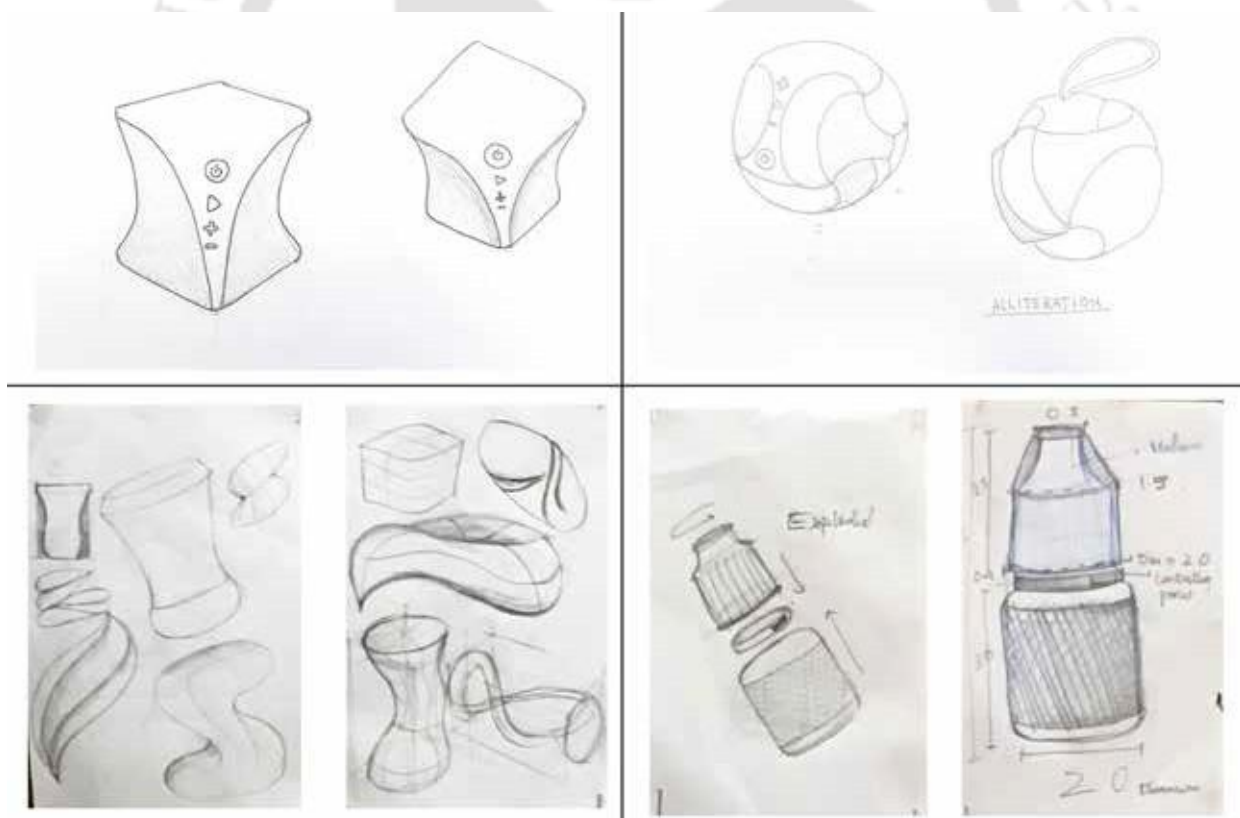


Figure. 4.2: Bluetooth Speaker Concept Sketches created by Design Students



Figure. 4.3: 3D CAD renders of Bluetooth Speaker Concept Sketches

#### 4.4 Hypotheses

Based on research gap 1, the authors formulated a hypothesis that has been broken into six working hypotheses. These were:

##### **Hypothesis:**

In the context of product form design, the use of the Figures of Speech (FoS) card tool might significantly affect the congruity of interest emotion attributes' rating of a concept by the designer and consumers.

##### **Working Hypothesis 1:**

Null Hypothesis 1 ( $H_1$ ):

There is no significant difference between the ratings of consumers and ratings of the designer on the Novelty attribute for a design concept in Treatment T1.

Alternate Hypothesis 1 ( $H_{1a}$ ):

There is a significant difference between ratings of consumers and ratings of the designer on the Novelty attribute for a design concept in Treatment T1.

**Working Hypothesis 2:**

Null Hypothesis 2 ( $H_2$ ):

There is no significant difference between ratings of consumers and ratings of the designer on the Novelty attribute for a design concept in Treatment T2.

Alternate Hypothesis 2 ( $H_{2a}$ ):

There is a significant difference between ratings of consumers and ratings of the designer on the Novelty attribute for a design concept in Treatment T2.

**Working Hypothesis 3:**

Null Hypothesis 3 ( $H_3$ ):

There is no significant difference between ratings of consumers and ratings of the designer on the Complexity attribute for a design concept in Treatment T1.

Alternate Hypothesis 3 ( $H_{3a}$ ):

There is a significant difference between ratings of consumers and ratings of the designer on the Complexity attribute for a design concept in Treatment T1.

**Working Hypothesis 4:**

Null Hypothesis 4 ( $H_4$ ):

There is no significant difference between ratings of consumers and ratings of the designer on the Complexity attribute for a design concept in Treatment T2.

Alternate Hypothesis 4 ( $H_{4a}$ ):

There is a significant difference between ratings of consumers and ratings of the designer on the Complexity attribute for a design concept in Treatment T2.

### **Working Hypothesis 5:**

Null Hypothesis 5 ( $H_5$ ):

There is no significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute for a design concept in Treatment T1.

Alternate Hypothesis 5 ( $H_{5a}$ ):

There is a significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute for a design concept in Treatments T1.

### **Working Hypothesis 6:**

Null Hypothesis 6 ( $H_6$ ):

There is no significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute for a design concept in Treatment T2.

Alternate Hypothesis 6 ( $H_{6a}$ ):

There is a significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute for a design concept in Treatment T2.

## **4.5 Experiment Design**

The experimental design consisted of two treatments: Treatment 1- Ideation session without the support of ideation tool (FoS card tool), and Treatment 2- Ideation session with the support of ideation tool (FoS card tool). The entire experimental design is explained in Figure 4.3.

### **4.5.1 Sampling and demographics**

A total of 37 people (consumers) participated in the study. However, in an initial plausibility check, three data sets had to be removed because the entries appeared inconsistent and untrustworthy. The mean age of the remaining group ( $N=34$ ) was 24.5 years ( $SD=2.03$  years). 20 men (58.8%), 14 women (41.2%) participated.

T1: without any ideation tool | Treatments  
 T2: with FoS card tool







	T1	T2
Designer 1 (D <sub>1</sub> )	Concept 1  (D <sub>1</sub> C <sub>1</sub> )	Concept 2  (D <sub>1</sub> C <sub>2</sub> )
Designer's Own Rating	Novelty D <sub>1</sub> C <sub>1</sub> V <sub>1</sub> _ _ _ _ _ X _ _	Novelty D <sub>1</sub> C <sub>2</sub> V <sub>1</sub> - X _ _ _ _ _
	Complexity D <sub>1</sub> C <sub>1</sub> V <sub>2</sub> X _ _ _ _ _ _	Complexity D <sub>1</sub> C <sub>2</sub> V <sub>2</sub> - _ X _ _ _ _
	Trendiness D <sub>1</sub> C <sub>1</sub> V <sub>3</sub> - _ X _ _ _ _	Trendiness D <sub>1</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
Consumers' Rating (S)	Novelty S <sub>1</sub> D <sub>1</sub> C <sub>1</sub> V <sub>1</sub> - _ _ X _ _ _	Novelty S <sub>1</sub> D <sub>1</sub> C <sub>2</sub> V <sub>1</sub> - _ _ X _ _ _
	Complexity S <sub>1</sub> D <sub>1</sub> C <sub>1</sub> V <sub>2</sub> - _ _ _ _ X _	Complexity S <sub>1</sub> D <sub>1</sub> C <sub>2</sub> V <sub>2</sub> - _ X _ _ _ _
	Trendiness S <sub>1</sub> D <sub>1</sub> C <sub>1</sub> V <sub>3</sub> - X _ _ _ _ _	Trendiness S <sub>1</sub> D <sub>1</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
	Novelty S <sub>33</sub> D <sub>1</sub> C <sub>1</sub> V <sub>1</sub> - _ _ X _ _ _	Novelty S <sub>33</sub> D <sub>1</sub> C <sub>2</sub> V <sub>1</sub> - _ _ _ _ X _
	Complexity S <sub>33</sub> D <sub>1</sub> C <sub>1</sub> V <sub>2</sub> - _ _ _ _ X _	Complexity S <sub>33</sub> D <sub>1</sub> C <sub>2</sub> V <sub>2</sub> - _ _ _ _ X _
	Trendiness S <sub>33</sub> D <sub>1</sub> C <sub>1</sub> V <sub>3</sub> - X _ _ _ _ _	Trendiness S <sub>33</sub> D <sub>1</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
Designer 2 (D <sub>2</sub> )	Concept 1  (D <sub>2</sub> C <sub>1</sub> )	Concept 2  (D <sub>2</sub> C <sub>2</sub> )
Designer's Own Rating	Novelty D <sub>2</sub> C <sub>1</sub> V <sub>1</sub> _ _ _ _ _ X _ _	Novelty D <sub>2</sub> C <sub>2</sub> V <sub>1</sub> - X _ _ _ _ _
	Complexity D <sub>2</sub> C <sub>1</sub> V <sub>2</sub> X _ _ _ _ _ _	Complexity D <sub>2</sub> C <sub>2</sub> V <sub>2</sub> - _ X _ _ _ _
	Trendiness D <sub>2</sub> C <sub>1</sub> V <sub>3</sub> - _ X _ _ _ _	Trendiness D <sub>2</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
Consumers' Rating (S)	Novelty S <sub>1</sub> D <sub>2</sub> C <sub>1</sub> V <sub>1</sub> - _ _ X _ _ _	Novelty S <sub>1</sub> D <sub>2</sub> C <sub>2</sub> V <sub>1</sub> - _ _ X _ _ _
	Complexity S <sub>1</sub> D <sub>2</sub> C <sub>1</sub> V <sub>2</sub> - _ _ _ _ X _	Complexity S <sub>1</sub> D <sub>2</sub> C <sub>2</sub> V <sub>2</sub> - _ X _ _ _ _
	Trendiness S <sub>1</sub> D <sub>2</sub> C <sub>1</sub> V <sub>3</sub> - X _ _ _ _ _	Trendiness S <sub>1</sub> D <sub>2</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
	Novelty S <sub>33</sub> D <sub>2</sub> C <sub>1</sub> V <sub>1</sub> - _ _ X _ _ _	Novelty S <sub>33</sub> D <sub>2</sub> C <sub>2</sub> V <sub>1</sub> - _ _ _ _ X _
	Complexity S <sub>33</sub> D <sub>2</sub> C <sub>1</sub> V <sub>2</sub> - _ _ _ _ X _	Complexity S <sub>33</sub> D <sub>2</sub> C <sub>2</sub> V <sub>2</sub> - _ _ _ _ X _
	Trendiness S <sub>33</sub> D <sub>2</sub> C <sub>1</sub> V <sub>3</sub> - X _ _ _ _ _	Trendiness S <sub>33</sub> D <sub>2</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
Designer 14 (D <sub>14</sub> )	Concept 1  (D <sub>14</sub> C <sub>1</sub> )	Concept 2  (D <sub>14</sub> C <sub>2</sub> )
Designer's Own Rating	Novelty D <sub>14</sub> C <sub>1</sub> V <sub>1</sub> _ _ _ _ _ X _ _	Novelty D <sub>14</sub> C <sub>2</sub> V <sub>1</sub> - X _ _ _ _ _
	Complexity D <sub>14</sub> C <sub>1</sub> V <sub>2</sub> X _ _ _ _ _ _	Complexity D <sub>14</sub> C <sub>2</sub> V <sub>2</sub> - _ X _ _ _ _
	Trendiness D <sub>14</sub> C <sub>1</sub> V <sub>3</sub> - _ X _ _ _ _	Trendiness D <sub>14</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
Consumers' Rating (S)	Novelty S <sub>1</sub> D <sub>14</sub> C <sub>1</sub> V <sub>1</sub> - _ _ X _ _ _	Novelty S <sub>1</sub> D <sub>14</sub> C <sub>2</sub> V <sub>1</sub> - _ _ X _ _ _
	Complexity S <sub>1</sub> D <sub>14</sub> C <sub>1</sub> V <sub>2</sub> - _ _ _ _ X _	Complexity S <sub>1</sub> D <sub>14</sub> C <sub>2</sub> V <sub>2</sub> - _ X _ _ _ _
	Trendiness S <sub>1</sub> D <sub>14</sub> C <sub>1</sub> V <sub>3</sub> - X _ _ _ _ _	Trendiness S <sub>1</sub> D <sub>14</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _
	Novelty S <sub>33</sub> D <sub>14</sub> C <sub>1</sub> V <sub>1</sub> - _ _ X _ _ _	Novelty S <sub>33</sub> D <sub>14</sub> C <sub>2</sub> V <sub>1</sub> - _ _ _ _ X _
	Complexity S <sub>33</sub> D <sub>14</sub> C <sub>1</sub> V <sub>2</sub> - _ _ _ _ X _	Complexity S <sub>33</sub> D <sub>14</sub> C <sub>2</sub> V <sub>2</sub> - _ _ _ _ X _
	Trendiness S <sub>33</sub> D <sub>14</sub> C <sub>1</sub> V <sub>3</sub> - X _ _ _ _ _	Trendiness S <sub>33</sub> D <sub>14</sub> C <sub>2</sub> V <sub>3</sub> - _ X _ _ _ _

Figure. 4.4: Visual Representation of the Experiment Design

## 4.6 Hypothesis Testing

### 4.6.1 Testing of Working Hypotheses

Before choosing the statistical test to test the hypotheses, normality tests were done on the data values. It is seen in table 4.2 and 4.3 that the data are significantly not similar to normally distributed data.

Table. 4.2: One-Sample Kolmogorov-Smirnov Test for Normality for Attribute Ratings in T1

		Novelty_T1	Complexity_T1	Trendiness_T1
N		476	476	476
Normal Parameters	Mean	5.03	3.75	4.73
	Std. Deviation	1.71	1.88	1.73
Most Extreme Differences	Absolute	0.20	0.16	0.18
	Positive	0.12	0.16	0.11
	Negative	-0.20	-0.13	-0.18
Kolmogorov-Smirnov Z		4.43	3.60	3.83
Asymp. Sig. (2-tailed)		0.001	0.001	0.001

Table. 4.3: Shapiro-Wilk Test for Normality for Attribute Ratings in T1

	Shapiro-Wilk Test		
	Statistic	df	Sig.
Novelty_T1	0.88	476	0.001
Complexity_T1	0.92	476	0.001
Trendiness_T1	0.91	476	0.001

Table. 4.4: One-Sample Kolmogorov-Smirnov Test for Normality for Attribute Ratings in T2

		Novelty_T2	Complexity_T2	Trendiness_T2
N		476	476	476
Normal Parameters	Mean	5.47	4.06	4.76
	Std. Deviation	1.62	1.88	1.71
Most Extreme Differences	Absolute	0.26	0.15	0.16
	Positive	0.17	0.15	0.10
	Negative	-0.26	-0.13	-0.16
Kolmogorov-Smirnov Z		5.74	3.23	3.51
Asymp. Sig. (2-tailed)		0.001	0.001	0.001

Table. 4.5: Shapiro-Wilk Test for Normality for Attribute Ratings in T2

	Shapiro-Wilk Test		
	Statistic	df	Sig.
Novelty_T2	0.82	476	0.001
Complexity_T2	0.93	476	0.001
Trendiness_T2	0.92	476	0.001

Since the results of the normality tests indicate that the data is not normally distributed, a non-parametric test is used for testing the hypotheses. The Wilcoxon Signed-Rank test, a non-parametric equivalent of the one sample t-test, is used to test the hypotheses.

The working hypothesis 1 testing is presented below using Wilcoxon Signed Rank Test for Design Concept 1 ( $D_1C_1$ ) for the Novelty attribute.

Table. 4.7: Mean and Std. Deviation of Novelty Rating on the Design Concept 1 in T1

	N	Mean	S.E. Mean	Std Dev	Variance	Minimum	Maximum
Age	34	24.56	0.35	2.03	4.13	21.00	29.00
Gender	34	1.41	0.09	0.50	0.25	Male	Female
Consumer_Novelty_T1	34	5.53	0.18	1.05	1.11	3.00	7.00

Table. 4.8: Ranks

		N	Mean Rank	Sum of Ranks
Consumer_Novelty_T1- Designer_Novelty_T1	Negative Ranks	27	14.00	378.00
	Positive Ranks	0	-	0.00
	Ties	7		
	Total	34		

Table. 4.9: Test Statistics

	Consumer_Novelty_T1 - Designer_Novelty_T1	Interpretation	Decision
Z	-4.62		
p-value (2-tailed)	0.001	Significant	Reject Null Hypothesis

Since  $p\text{-value}=0.001 < 0.05$ , we reject  $H_1$  for  $D_1C_1$ .

At the 5% level, there is enough evidence to support the claim that there is a significant difference between ratings of consumers and ratings of the designer on the Novelty attribute for the design concept 1 in Treatment T1.

Similarly, statistical analysis was conducted for design-specific agreement between consumers'

rating and designers' rating for Novelty attribute for all the design concepts in T1 and T2.

Table. 4.10: The Wilcoxon Signed Rank Test for Novelty Rating in T1

Treatment	Design Concept	Consumers' rating		Designers' rating	p-value
		Mean	SD		
T1	D <sub>1</sub> C <sub>1</sub>	5.53	1.05	7.00	<0.05
	D <sub>2</sub> C <sub>1</sub>	4.15	1.65	2.00	<0.05
	D <sub>3</sub> C <sub>1</sub>	5.47	1.64	3.00	<0.05
	D <sub>4</sub> C <sub>1</sub>	5.18	1.40	7.00	<0.05
	D <sub>5</sub> C <sub>1</sub>	3.82	1.73	5.00	<0.05
	D <sub>6</sub> C <sub>1</sub>	5.82	0.94	4.00	<0.05
	D <sub>7</sub> C <sub>1</sub>	3.56	1.50	1.00	<0.05
	D <sub>8</sub> C <sub>1</sub>	6.74	0.75	4.00	<0.05
	D <sub>9</sub> C <sub>1</sub>	3.71	1.73	6.00	<0.05
	D <sub>10</sub> C <sub>1</sub>	5.59	1.39	2.00	0.207
	D <sub>11</sub> C <sub>1</sub>	4.26	1.88	6.00	<0.05
	D <sub>12</sub> C <sub>1</sub>	5.85	1.28	6.00	0.840
	D <sub>13</sub> C <sub>1</sub>	6.00	0.98	4.00	<0.05
	D <sub>14</sub> C <sub>1</sub>	4.68	1.61	6.00	<0.05

At the 5% level, there is enough evidence to support the claim that there is a significant difference between ratings of consumers and ratings of the designer on the Novelty attribute for 12 design concepts out of 14 design concepts, in Treatment T1. In the current sample, 85.7% times there is a significant difference between ratings of consumers and ratings of the designer on the Novelty attribute. Thus, **Null Hypothesis 1 (H<sub>1</sub>) is rejected and Alternate Hypothesis (H<sub>1a</sub>) is accepted.**

Table. 4.11: The Wilcoxon Signed Rank Test for Novelty Rating in T2

Treatment	Design Concept	Consumers' rating		Designers' rating	p-value
		Mean	SD		
T2	D <sub>1</sub> C <sub>2</sub>	3.94	1.81	4.00	0.826
	D <sub>2</sub> C <sub>2</sub>	4.62	1.54	5.00	0.168
	D <sub>3</sub> C <sub>2</sub>	6.21	1.15	6.00	0.063
	D <sub>4</sub> C <sub>2</sub>	4.06	1.82	4.00	0.936
	D <sub>5</sub> C <sub>2</sub>	6.03	0.83	5.00	<0.05
	D <sub>6</sub> C <sub>2</sub>	6.03	1.47	6.00	0.290
	D <sub>7</sub> C <sub>2</sub>	5.71	1.27	1.00	<0.05
	D <sub>8</sub> C <sub>2</sub>	6.06	1.19	6.00	0.095
	D <sub>9</sub> C <sub>2</sub>	5.74	1.19	3.00	0.257
	D <sub>10</sub> C <sub>2</sub>	6.65	0.65	7.00	<0.05
	D <sub>11</sub> C <sub>2</sub>	5.79	1.45	6.00	0.781

	$D_{12}C_2$	5.97	1.00	3.00	0.061
	$D_{13}C_2$	5.09	1.64	5.00	0.706
	$D_{14}C_2$	4.68	1.70	5.00	0.344

At the 5% level, there is enough evidence to support the claim that there is no significant difference between ratings of consumers and ratings of the designer on the Novelty attribute for 11 design concepts out of 14 design concepts, in Treatment T2. In the current sample, 78.5% times there is no significant difference between ratings of consumers and ratings of the designer on the Novelty attribute. Thus, we **failed to reject Null Hypothesis 2 (H<sub>2</sub>)**.

Similarly, statistical analysis was conducted for design-specific agreement between consumers' rating and designers' rating for Complexity attribute for all the design concepts in T1 and T2.

Table. 4.12: The Wilcoxon Signed Rank Test for Complexity Rating in T1

Treatment	Design Concept	Consumers' rating		Designers' rating	p-value
		Mean	SD		
T1	$D_1C_1$	2.82	1.47	5.00	<0.05
	$D_2C_1$	2.74	1.19	5.00	<0.05
	$D_3C_1$	5.35	1.57	2.00	<0.05
	$D_4C_1$	2.59	1.35	2.00	0.014
	$D_5C_1$	3.15	1.56	2.00	<0.05
	$D_6C_1$	4.79	1.68	2.00	<0.05
	$D_7C_1$	3.94	1.76	2.00	<0.05
	$D_8C_1$	5.47	1.78	2.00	<0.05
	$D_9C_1$	2.82	1.38	1.00	<0.05
	$D_{10}C_1$	4.88	1.37	2.00	<0.05
	$D_{11}C_1$	2.29	1.34	1.00	<0.05
	$D_{12}C_1$	4.15	1.71	2.00	<0.05
	$D_{13}C_1$	5.09	1.58	3.00	<0.05
	$D_{14}C_1$	2.35	1.20	7.00	<0.05

At the 5% level, there is enough evidence to support the claim that there is a significant difference between ratings of consumers and ratings of the designer on the Complexity attribute for 12 design concepts out of 14 design concepts, in Treatment T1. In the current sample, 85.7% times there is a significant difference between ratings of consumers and ratings of the designer on the Complexity attribute. Thus, **Null Hypothesis 3 (H<sub>3</sub>) is rejected and Alternate Hypothesis (H<sub>3a</sub>) is accepted**.

Table. 4.13: The Wilcoxon Signed Rank Test for Complexity Rating in T2

Treatment	Design Concept	Consumers' rating		Designers' rating	p-value
		Mean	SD		
T2	D <sub>1</sub> C <sub>2</sub>	2.82	1.22	3.00	0.317
	D <sub>2</sub> C <sub>2</sub>	2.26	1.02	2.00	0.141
	D <sub>3</sub> C <sub>2</sub>	5.15	1.69	5.00	0.552
	D <sub>4</sub> C <sub>2</sub>	2.41	1.48	2.00	0.115
	D <sub>5</sub> C <sub>2</sub>	3.97	1.59	4.00	0.956
	D <sub>6</sub> C <sub>2</sub>	4.88	1.57	5.00	0.560
	D <sub>7</sub> C <sub>2</sub>	3.79	1.67	3.00	<0.05
	D <sub>8</sub> C <sub>2</sub>	6.09	1.38	6.00	0.231
	D <sub>9</sub> C <sub>2</sub>	4.06	1.87	4.00	0.693
	D <sub>10</sub> C <sub>2</sub>	5.24	1.79	5.00	0.061
	D <sub>11</sub> C <sub>2</sub>	3.85	1.65	4.00	0.718
	D <sub>12</sub> C <sub>2</sub>	4.24	1.81	4.00	0.444
	D <sub>13</sub> C <sub>2</sub>	4.21	1.55	4.00	0.457
	D <sub>14</sub> C <sub>2</sub>	3.82	1.71	4.00	0.660

At the 5% level, there is enough evidence to support the claim that there is no significant difference between ratings of consumers and ratings of the designer on the Complexity attribute for 13 design concepts out of 14 design concepts, in Treatment T2. In the current sample, 92.8% times there is no significant difference between ratings of consumers and ratings of the designer on the Complexity attribute. Thus, we **failed to reject Null Hypothesis 4 (H<sub>4</sub>)**.

Similarly, statistical analysis was conducted for design-specific agreement between consumers' rating and designers' rating for Trendiness attribute for all the design concepts in T1 and T2.

Table. 4.14: The Wilcoxon Signed Rank Test for Trendiness Rating in T1

Treatment	Design Concept	Consumers' rating		Designers' rating	p-value
		Mean	SD		
T1	D <sub>1</sub> C <sub>1</sub>	5.12	1.01	6.00	<0.05
	D <sub>2</sub> C <sub>1</sub>	4.29	1.55	6.00	<0.05
	D <sub>3</sub> C <sub>1</sub>	3.26	1.75	2.00	<0.05
	D <sub>4</sub> C <sub>1</sub>	5.29	1.14	6.00	<0.05
	D <sub>5</sub> C <sub>1</sub>	3.59	0.26	6.00	<0.05
	D <sub>6</sub> C <sub>1</sub>	6.26	0.79	4.00	<0.05
	D <sub>7</sub> C <sub>1</sub>	2.85	1.35	4.00	<0.05
	D <sub>8</sub> C <sub>1</sub>	6.41	0.86	5.00	<0.05
	D <sub>9</sub> C <sub>1</sub>	3.50	1.66	6.00	<0.05
	D <sub>10</sub> C <sub>1</sub>	4.94	1.76	2.00	<0.05
	D <sub>11</sub> C <sub>1</sub>	4.82	1.70	6.00	<0.05

	$D_{12}C_1$	5.71	1.14	4.00	<0.05
	$D_{13}C_1$	5.24	1.52	3.00	<0.05
	$D_{14}C_1$	5.12	1.37	7.00	<0.05

At the 5% level, there is enough evidence to support the claim that there is a significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute for 14 design concepts out of 14 design concepts, in Treatment T1. In the current sample, 100% times there is a significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute. Thus, **Null Hypothesis 5 ( $H_5$ ) is rejected and Alternate Hypothesis ( $H_{5a}$ ) is accepted.**

Table. 4.15: The Wilcoxon Signed Rank Test for Trendiness Rating in T2

Treatment	Design Concept	Consumers' rating		Designers' rating	p-value
		Mean	SD		
T2	$D_1C_2$	4.12	1.77	6.00	0.704
	$D_2C_2$	3.91	1.46	6.00	0.647
	$D_3C_2$	5.79	0.91	2.00	0.183
	$D_4C_2$	3.74	1.80	6.00	0.526
	$D_5C_2$	4.82	1.34	6.00	0.510
	$D_6C_2$	6.26	0.79	4.00	<0.05
	$D_7C_2$	4.41	1.50	4.00	<0.05
	$D_8C_2$	6.71	0.46	5.00	0.122
	$D_9C_2$	3.88	1.67	6.00	0.609
	$D_{10}C_2$	6.21	0.81	2.00	0.063
	$D_{11}C_2$	4.12	1.92	6.00	0.721
	$D_{12}C_2$	4.62	1.23	4.00	0.089
	$D_{13}C_2$	4.50	1.48	3.00	0.081
	$D_{14}C_2$	3.82	1.85	7.00	0.558

At the 5% level, there is enough evidence to support the claim that there is no significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute for 12 design concepts out of 14 design concepts, in Treatment T2. In the current sample, 85.7% times there is no significant difference between ratings of consumers and ratings of the designer on the Trendiness attribute. Thus, we **failed to reject Null Hypothesis 6 ( $H_6$ ).**

Based on the empirical evidence, it can be concluded that, **in the context of product form design, the use of the Figures of Speech (FoS) card tool significantly affects the congruity of interest emotion attributes' rating by the designer and consumers.** Thus, it can be inferred that the concepts generated using the FoS card tool exhibit a better emotional continuity.

#### 4.7 Product-Consumer Interaction Scenarios Prior to the Product Purchase

Designers devote a substantial period of time to conceive and develop their designs. In contrast, they have a concise window of opportunity to convey their design intention to the consumers through their product. With the prevalence of e-commerce, product sales take place in non-traditional ways, and consumers interact with products in varied purchase scenarios (Vergara et al., 2011). In this regard, the consumer interaction with a product in the context of ‘before the product purchase’ can be classified into three categories: product representation (image, website, brochure), hands-off (visual interaction with the physical product), and hands-on (multisensory interaction with the physical product). The same classification is mentioned in figure 4.4 with an example of eyewear.



Figure. 4.4: Product-Consumer Interaction Scenarios Prior to the Product Purchase

As explained in the section ‘Fundamental Product Design Elements and Emotions’, the focus of current research is on the visual design of the product and associated initial emotional response; thus, the ‘product representation’ scenario in figure 4.10 was considered for initial investigation. Further, a few of the design concepts developed by design students are made into physical prototypes (figure 4.5) to investigate the ‘hands-off’ scenario in figure 4.4. It was performed to investigate if there was any significant change in the congruity of interest emotion attributes’ rating of a concept by the designer and consumers.

For this study, 20 design concepts developed by 10 designers were chosen based on the possibility of getting them prototyped. These 20 design concepts (10 in T1 and 10 in T2) were shown to the same 34 consumers after a gap of 4 weeks. Consumers then rated each concept on the interest emotion attributes of Novelty, Complexity, and Trendiness on a seven-point semantic differential scale. The quantitative data obtained is then analyzed to test the hypothesis.

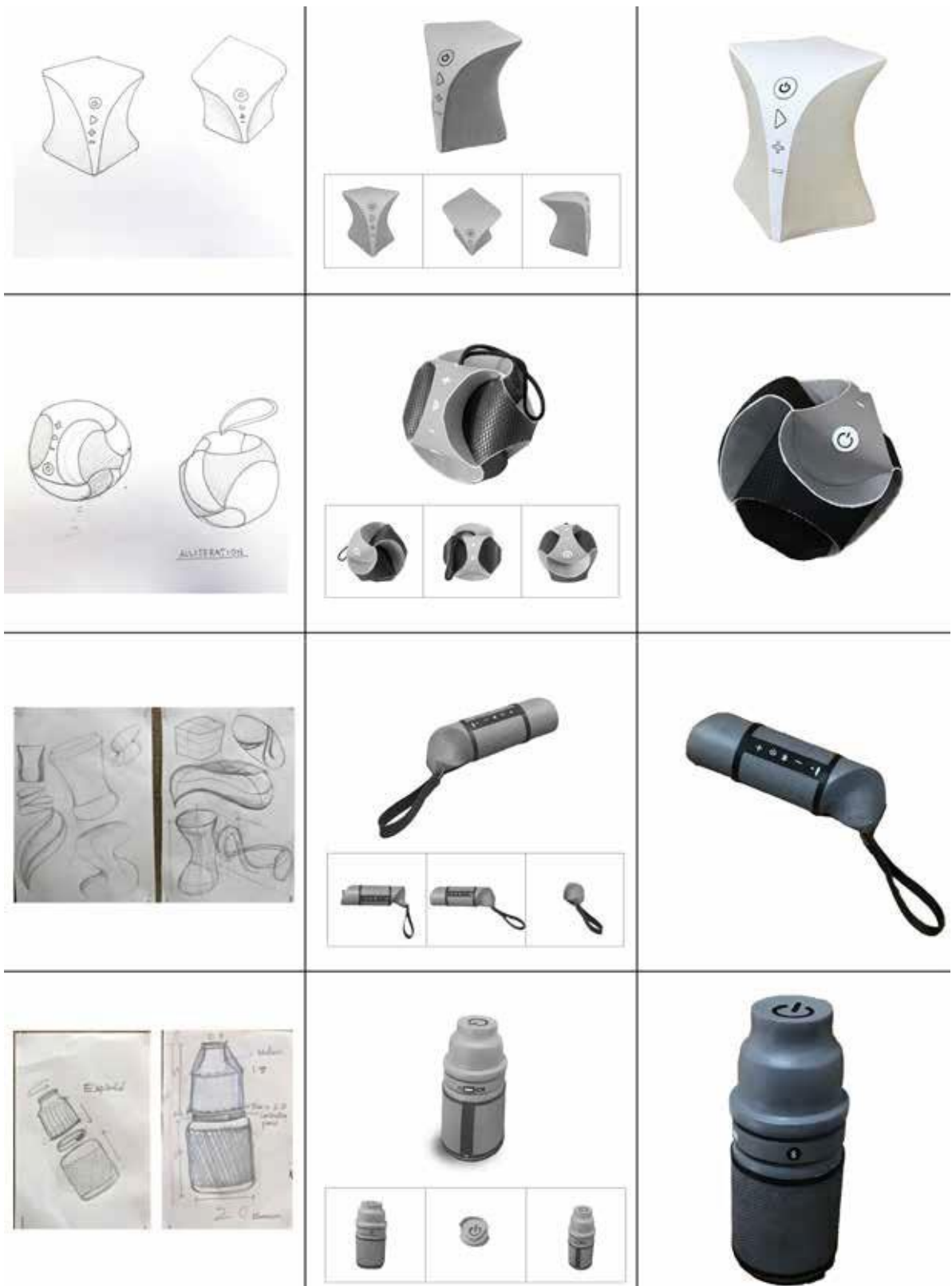


Figure. 4.5: Concept Sketches, 3D CAD renders, and Physical Prototypes

Based on the empirical evidence, it can be **concluded that even when the consumer interaction with a product in the context of ‘before the product purchase’ has been changed from ‘product representation’ to ‘hands-off’, there is no significant change in the interest attribute ratings.**

#### **4.8 Creativity and Idea Generation Ability**

Based on research gap 2, it is possible to formulate one more hypothesis that has been further broken down into two working hypotheses.

Hypothesis: In the context of product form design, the use of the Figures of Speech (FoS) card tool might significantly affect the designers' creativity and idea generation ability.

##### **Working Hypothesis 7:**

Null Hypothesis ( $H_7$ ):

There is no significant effect of the use of the Figures of Speech (FoS) card tool on the designers' creativity.

Alternate Hypothesis ( $H_{7a}$ ):

There is a significant effect of the use of the Figures of Speech (FoS) card tool on the designers' creativity.

##### **Working Hypothesis 8:**

Null Hypothesis ( $H_8$ ):

There is no significant effect of the use of the Figures of Speech (FoS) card tool on the designers' idea generation ability.

Alternate Hypothesis ( $H_{8a}$ ):

There is a significant effect of the use of the Figures of Speech (FoS) card tool on the designers' idea generation ability.

##### **Testing the Working Hypothesis 7**

To test the above-mentioned hypotheses, the 28 design concepts generated by the design students in T1 and T2 were given to expert evaluators. The experts rated the concepts on the creativity assessment rating factors mentioned in the Creativity Assessment Guidelines (Appendix-A). The rating scale is mentioned in Creativity Evaluation Sheet (Appendix-B). The number of experts was five, as per the discussion mentioned in section 2.10.3. The expert selection criteria were decided as the expert should have a minimum of 6 years of experience in the design industry/academia. The particulars of the expert evaluators are mentioned in Details of Expert Evaluators

(Appendix-C).

Since the number of expert evaluators was five, the data was assumed to be not normally distributed, and a non-parametric test was used for testing the hypotheses. The Wilcoxon Signed-Rank Test, a non-parametric equivalent of the related sample t-test, is used to test the hypotheses. Tables 4.16 shows the mean values of the creativity assessment ratings by expert evaluators in T1 and T2. Statistical analysis was conducted for each of the factors.

Table. 4.16: Mean Values of the Creativity Assessment Ratings by Expert Evaluators in T1 and T2

<b>Treatment T1</b>				
<b>Design Concept</b>	<b>Novelty</b>	<b>Appropriateness</b>	<b>Elaboration</b>	<b>Surprise</b>
D <sub>1</sub> C <sub>1</sub>	3.60	4.40	3.40	4.00
D <sub>2</sub> C <sub>1</sub>	2.40	3.80	2.80	2.60
D <sub>3</sub> C <sub>1</sub>	5.60	3.20	6.00	6.20
D <sub>4</sub> C <sub>1</sub>	4.80	4.20	3.00	5.00
D <sub>5</sub> C <sub>1</sub>	4.40	3.80	2.60	3.80
D <sub>6</sub> C <sub>1</sub>	2.40	4.40	1.80	3.40
D <sub>7</sub> C <sub>1</sub>	4.40	5.80	5.60	4.40
D <sub>8</sub> C <sub>1</sub>	6.00	4.00	2.40	5.40
D <sub>9</sub> C <sub>1</sub>	4.60	3.80	1.80	3.80
D <sub>10</sub> C <sub>1</sub>	4.40	5.80	5.60	4.40
D <sub>11</sub> C <sub>1</sub>	4.80	3.40	2.60	5.20
D <sub>12</sub> C <sub>1</sub>	5.20	5.60	3.80	5.00
D <sub>13</sub> C <sub>1</sub>	6.20	3.80	4.80	6.20
D <sub>14</sub> C <sub>1</sub>	3.40	3.60	3.80	3.20

<b>Treatment T2</b>				
<b>Design Concept</b>	<b>Novelty</b>	<b>Appropriateness</b>	<b>Elaboration</b>	<b>Surprise</b>
D <sub>1</sub> C <sub>2</sub>	6.00	5.40	4.40	6.40
D <sub>2</sub> C <sub>2</sub>	3.80	4.60	3.40	5.40
D <sub>3</sub> C <sub>2</sub>	6.60	5.40	6.20	6.60
D <sub>4</sub> C <sub>2</sub>	6.20	5.00	5.40	5.80
D <sub>5</sub> C <sub>2</sub>	6.20	4.60	4.20	6.20
D <sub>6</sub> C <sub>2</sub>	5.40	4.40	3.60	6.00
D <sub>7</sub> C <sub>2</sub>	5.20	4.60	5.00	4.80
D <sub>8</sub> C <sub>2</sub>	4.80	6.80	5.40	4.60
D <sub>9</sub> C <sub>2</sub>	5.80	5.60	4.80	5.00
D <sub>10</sub> C <sub>2</sub>	5.20	5.20	5.00	5.20
D <sub>11</sub> C <sub>2</sub>	6.00	5.20	4.20	6.40

$D_{12}C_2$	5.00	4.40	4.40	4.80
$D_{13}C_2$	4.60	5.20	5.60	4.20
$D_{14}C_2$	5.20	5.60	4.20	5.80

Table. 4.17: The Wilcoxon Signed Rank Test for Novelty Rating

Ranks				
		N	Mean Rank	Sum of Ranks
Novelty_T1 - Novelty_T2	Negative Ranks	11	7.68	84.50
	Positive Ranks	3	6.83	20.20
	Ties	0		
	Total	14		

Test Statistics	
	Novelty_T1 - Novelty_T2
Z	-2.01
p-value (2-tailed)	0.044

p-value=0.044 < 0.05

Table. 4.18: The Wilcoxon Signed Rank Test for Appropriateness Rating

Ranks				
		N	Mean Rank	Sum of Ranks
Appropriateness_T1 - Appropriateness_T2	Negative Ranks	10	7.70	77.00
	Positive Ranks	3	4.67	14.00
	Ties	1		
	Total	14		

Test Statistics	
	Appropriateness_T1 - Appropriateness_T2
Z	-2.20
p-value (2-tailed)	0.028

p-value=0.028 < 0.05

Table. 4.21: The Wilcoxon Signed Rank Test for Elaboration Rating

Ranks				
		N	Mean Rank	Sum of Ranks
Elaboration_T1 - Elaboration_T2	Negative Ranks	12	8.17	98.00
	Positive Ranks	2	3.50	7.00
	Ties	0		
	Total	14		

Test Statistics	
	Elaboration_T1 - Elaboration_T2
Z	-2.86
p-value (2-tailed)	0.004

p-value=0.004 < 0.05

Table. 4.22: The Wilcoxon Signed Rank Test for Surprise Rating

Ranks				
		N	Mean Rank	Sum of Ranks
Surprise_T1 - Surprise_T2	Negative Ranks	11	8.09	89.00
	Positive Ranks	3	5.33	16.00
	Ties	0		
	Total	14		

Test Statistics	
	Surprise_T1 - Surprise_T2
Z	-2.29
p-value (2-tailed)	0.022

p-value=0.022 < 0.05

Since for all four creativity assessment rating factors, the p-value is <0.05, we **reject the null hypothesis H<sub>7</sub>** and conclude that **using the Figures of Speech (FoS) card significantly affects the designers' creativity.**

### Testing the Working Hypothesis 8

The mean value of the rating given on the variety factor by the expert evaluators in T1 and T2 is compared in Figure 4.6.

It is quite evident from the graph that the rating on the variety factor has increased from 4.8 to 6. Therefore, it can be concluded that the use of the FoS card tool has a positive effect on the number of different ideas created by the group of design students in an ideation session. Thus, we reject the Null Hypothesis H<sub>8</sub> and conclude that **the use of the Figures of Speech (FoS) card tool has a significant effect on the designers' idea generation ability.**

## 4.9 Discussion and Findings

The experiments show that the application of the FoS card methodology causes students to pay



Figure. 4.6: Variety Facor Rating in T1 and T2

more attention to the form elements and use them to communicate desired emotion. The tool also develops a deeper understanding of the form-emotion relation and ignites a thought process distinct from an established cognitive thinking pattern. The data analysis results show a significant change in the interest attribute ratings by the consumers when the design concepts are generated using the FoS card tool. The results demonstrate that there is better emotional continuity when the students use the FoS card tool during the ideation session. It is also found that there is no significant change in the interest attribute rating by the consumers when the interaction is changed from 'product representation' to 'hands-off'.

## **Chapter 5. Conclusion, Limitations and Future Scope of Work**

### **5.1 Introduction**

The present chapter briefly discusses the novelties (key contributions) of the present thesis. This chapter also includes how research objectives have been fulfilled and how hypotheses have been tested. This chapter also lists the novelties of present research in terms of methodology and knowledge-base. This chapter ends with limitations, future scopes, and an overall conclusion of the present thesis work.

### **5.2 Novelties (key contributions) of the Present Thesis**

- In the present research, we conducted an integrative review of articles relevant to the topic of design and emotion. Through the critical analysis of these articles, four main themes or categories emerged: 1. The Terminology used in Emotion Research, 2. Consumer Emotions and their relation with the other factors in the ‘before product purchase’ scenario, 3. Theories of Product Emotion, and 4. Assessment of Emotion. The integration of valuable insights drawn from the review of the first two categories has resulted in developing a conceptual framework of consumer emotional response before product purchase (Figure 1.5). A key contribution of this study is that the insights gained from the review of the available literature provide an overview of the range of product design factors that are most likely to influence the consumer emotional response to products in the pre-purchase context. Consequently, the proposed framework is an important guideline on how these factors link with each other. Moreover, the framework shows there are direct, indirect, or both (direct and indirect) relationships between specific factors with consumer emotions. For example, the Environmental Factors directly impact consumer emotions, while the factors in the Judgement Criteria cluster have direct and indirect influences on consumer emotions. The study also describes the application of the proposed framework citing several relevant research examples from the domain of design and emotion. A design team can gain valuable insights by consciously categorizing the context-specific design intents based on the cluster and factors discussed in the framework. Moreover, the framework presented is an effective means for suggesting promising future research directions to conduct studies based on specific parts and contributing factors of the framework, which are unexplored previously, and investigate their role in influencing consumer emotions.
- This current study proposes a framework for identifying research opportunities (Figure 1.11) describing the key stages and their attributes. The proposed pedagogical framework encourages design research students to perform the task of identification of research gap in a much more structured way. Moreover, it is observed during our study that the framework

(Figure 1.11) also assists in dealing with the enormous amount of data gathered by organizing it into research relevant areas and thereby reducing the confusion of deciding on which area to focus. This systematic approach in identifying the research gap serves to set the initial point of reference for the research and form the logical basis for it. Thus, the direction of research is evident in the preliminary stages, which helps to refrain from a shift in research focus at later stages.

- Interdisciplinary teamwork is becoming the standard in every field as it offers an opportunity to formulate a more comprehensive understanding of an issue that any single discipline may be unable to provide. Designers are increasingly integrated into such interdisciplinary teams because of their creative abilities and skills to humanize technology by thinking beyond functional needs. However, it was observed during the study, the functioning of an interdisciplinary team often turns out to be ineffective due to conflicting working styles and behaviours of the members. In this regard, Belbin's project team model provided insights for building a team with a balance of the team and functional roles. Further, it assisted in assigning appropriate stage leads at different stages of the proposed research opportunity framework. Most importantly, it illustrated how the variations in the team and functional roles could be utilized constructively in an interdisciplinary team.
- The review of seventeen EAMs, conducted in the present study, resulted in a taxonomy based on the way of recording emotion-related information. Furthermore, a criteria for comparing these methods on eight factors that are manifested in the form of questions and their associated measures has also been developed. One can examine an EAM on these identified eight factors to choose the best method suited for the context of the undertaken research.
- The FoS card tool developed in the current study is a source of inspiration representing textual and visual cues for emotive form ideation. The application of the FoS card methodology causes students to pay more attention to the form elements and use them to communicate desired emotion. The tool also develops a deeper understanding of the form-emotion relation and ignites a thought process distinct from an established cognitive thinking pattern. The proposed tool is a systematic pedagogical approach rather than an intuitive ideation approach. It is an innovation toolbox developed out of a need to create a broader range of emotive form ideas. It combines activities of choosing the FoS inspiration card, analysis and synthesis of form elements represented in that card, establishing a relation between the form elements and the emotion to be communicated.
- The shaping emotions framework (Figure 3.2) developed during the present study can be used by design students and practitioners in the early stage of the design process to create a pool of

emotive form ideas. The framework is an emotive design approach that helps generate a wider range of form design alternatives during the ideation stage and boosts their creativity skills in the context of the product emotions and form design. Moreover, it aids in determining whether design ideas elicit intended product emotions.

### 5.3 Fulfillment of the Objectives and Testing of Hypotheses

**Obj 1.** To create an emotive design approach that helps generate a wider range of form design alternatives during the ideation stage.

The ratings of expert evaluators on the variety factor, a measure of assessment of ideation variety, were significantly higher in the ideation session T2. It shows that the shaping emotions framework helped design students generate a more comprehensive range of ideas that differ in their embodiment and details. Thus, **objective 1 of the research was fulfilled.**

**Obj 2.** To evolve a product form design tool/method for product designers that boosts their creativity skills in the context of the product emotions and form design.

The ratings of expert evaluators on all four factors considered for creativity assessment showed a significantly higher value in the design ideas generated in T2. It shows that the FoS card tool helped to boost the creativity of participants in terms of product form generation. Thus, **objective 2 of the research was fulfilled.**

**Obj 3.** To develop a framework to identify the designer's intended product emotion and to determine whether design ideas elicit intended product emotions.

The interest emotion attribute survey was conducted to determine the extent of congruity between designers' ratings and consumers' ratings. Data pertaining to the ratings of novelty, complexity, and trendiness attributes showed a significant effect of the use of the FoS card tool on the congruity between the ratings. The application of the Shaping Emotions Framework helped designers to comprehend whether their intended product emotions were realized by the consumers. Thus, **objective 3 of the research was fulfilled.**

The two hypotheses given below were broken into eight working hypotheses and tested using the Wilcoxon Signed Rank Test.

- In the context of product form design, the use of the Figures of Speech (FoS) card tool might significantly affect the congruity of interest emotion attributes' rating of a concept by the designer and consumers.

- In the context of product form design, the use of the Figures of Speech (FoS) card tool might significantly affect the designers' creativity and idea generation ability.

The hypothesis testing was elaborately explained in Chapter 4 of the thesis.

#### **5.4 Limitations and Recommendations for Further Research**

- In the study, the subject of analysis is limited to product design and emotion. However, a much more coherent and critical analysis is needed to generalize the current findings to be applied to other design disciplines like architectural design and graphic design.
- Furthermore, the conceptual framework of consumer emotional response before product purchase (Figure 1.5) does not accommodate certain factors such as consumer characteristics like gender, cultural background, and personality traits. The limitations of this study provide some direction for future research. For example, a quantitative study could be undertaken to confirm the relation between the choice of product material and the corresponding consumer emotional response when the same set of materials are examined with different senses. The numerical data obtained through such a study would allow a detailed understanding at the elemental level of the framework. Furthermore, the relevance of the framework could be investigated considering products in different market segments to allow a broader generalization of the findings. Similarly, determining the hierarchy of all the elements in a cluster that affects pre-purchase emotional response would provide more knowledge of the nature of the relationship existing among them. Finally, the study increases our understanding of the relationship between Emotion and Design, and designers can effectively utilize it to discover further opportunities for new product conception.
- The current FoS card tool consists of six figures of speech in the English language. The tool can be further expanded to accommodate more figures of speech after confirming their suitability to the product form design context. Moreover, each figure of speech card consists of three existing examples of product design that fit into the contextual definition. In the future, more such suitable examples can be included to make the tool more comprehensive.
- At present, the FoS card tool is in the form of six physical inspiration cards. In the future, the same card tool can be extended to a digital medium such as a website or a mobile phone application. This digital tool can provide a platform to quickly visualize more number inspirational images for each Figure of Speech. Moreover, it can allow uploading generated ideas to facilitate group ideation and collaboration.
- The current study investigates a scenario where the first-time visual interaction of a user with the product, i.e., when users see the product for the first time through the visual sense. The idea

here was to evoke interest in users when they see the product for the first time. The present investigation only looks at the possibilities of eliciting interest through product form. In the future, the other fundamental elements of design, such as color, material, etc., can be explored to elicit interest. Moreover, the entire research can move beyond only visual sense, and other senses like touch, hearing, smell, and taste can also be examined to evoke various positive emotions.

- Available literature on emotional design does not address the case of consumer behavior when dissimilar emotional responses are elicited through two different senses. For instance, when a consumer interacts with a product, the visual sense evokes a positive emotional response, while the hearing sense evokes a negative emotional response. When multiple senses (e.g., vision and hearing) elicit an incongruent emotional response to a product, what is consumer behavior? It will also be interesting to determine which emotional response (positive or negative) dominates in such cases.
- The Conceptual framework (Figure 1.5) also reveals that emotions do not appear “out of nowhere” as the simple by-product of a given stimulus. Instead, they are influenced by previous emotional states, or pre-existing individual traits, past experience, and other contextual factors like advertising. Therefore, a designer working with emotions should be able to identify and measure emotional profiles or pre-existing individual/contextual characteristics that can influence the effectiveness of emotion-based product design. Identifying these ‘emotional profiles’ would help designers develop products with long-lasting emotional benefits. Thus, research question for future work would be: What are users’ emotional profiles that can influence emotion-based products or services to allow designers to promote lasting emotional benefits?

## **5.5 Conclusion**

The role of emotions in the field of product design has grown exponentially in the past several years. Since emotions play a crucial role in attracting attention and impacting decision-making, design based on emotions can make a valuable contribution to creating a comprehensive user experience. Although designers and researchers have recognized the importance of emotions in the design of a product, the task of realizing the emotional impact a design has on the consumer is quite challenging. For this reason, the present thesis provided a comprehensive understanding of the terms used in emotions research, human emotions and their association with design, analysis of seminal theories of product emotion, existing emotive product form ideation methods, and Emotions Assessment Methods (EAMs). This extensive review helped to create a knowledge base for the emerging field of emotion and design. The understanding developed from this foundation

study has resulted in developing a ‘Conceptual Framework for Consumer Emotional Response before Product Purchase’. This framework formed a basis for proposing the concept of ‘emotional continuity’ and ‘Shaping Emotion Framework’.

The application of the Shaping Emotion Framework developed in the present work showed the generation of a wider range of creative and emotive product form ideas. The framework also helped identify whether the generated ideas are emotionally continuous. The Figures of Speech (FoS) card tool, one of the parts of the Shaping Emotion framework, is an effective approach to emotive form generation. Moreover, the tool helped to trigger fresh ideas for product form when the designers face a mental block. The comparative analysis of Emotion Assessment Methods (EAMs) performed as a part of current work helps to identify critical criteria to be considered for the application of each method. The comparison matrix of EAMs guides novice researchers in deciding the most suitable EAM for an individual’s research context. In addition to this, the ‘Research Opportunity Identification Process’ formulated and followed in the current work is a unique way to discover research gaps. It is a structured approach that categorizes a large amount of data in research-relevant areas. Most importantly, it illustrated how the variations in the team and functional roles could be utilized constructively in an interdisciplinary team.

In conclusion, the present thesis work significantly contributes to the knowledge-base, and emotive product form design methodology in the context of product design and emotion. The research method and material used in the present research could be replicated in other similar cases of product form development. The methodology used in the present thesis might be adopted directly by researchers, design practitioners, and design students to create product forms that elicit intended emotive responses.

## 6 References

- Adaval, R. (2001). Sometimes It Just Feels Right: The Differential Weighting of Affect-Consistent and Affect-Inconsistent Product Information. *Journal of Consumer Research*, 28(1), 1–17. <https://doi.org/10.1086/321944>
- Abraham, R. (1999). Emotional intelligence in organizations: A conceptualization. *Genetic, Social, and General Psychology Monographs*, 125(2), 209–224.
- Ahmed, S., & Boelskifte, P. (2006). Investigation Of Designers Intentions and a Users' Perception of Product Character. *Nordesign* , (September), 372-381.
- Alcántaraa, E., Artachob, M. A., González, J. C., & García, A. C. (2005). Application of product semantics to footwear design. Part I—Identification of footwear semantic space applying differential semantics. *International Journal of Industrial Ergonomics*, 35(8), 713–725.
- ANNA '18; Advances in Neural Networks and Applications 2018 : 15-17 Sept. 2018. (2018). International Neural Network Society,; Verband der Elektrotechnik, Elektronik, Informationstechnik,; Institute of Electrical and Electronics Engineers. Retrieved from <https://ieeexplore.ieee.org/servlet/opac?punumber=8576698>
- Armstrong, L. (1991, December). It Started With An Egg. *Business* . Retrieved from <https://www.bloomberg.com/news/articles/1991-12-01/it-started-with-an-egg>
- Ashby, M., & Johnson, K. (2003). The art of materials selection. *Materials Today*, 6 (12), 24-35. [https://doi.org/10.1016/S1369-7021\(03\)01223-9](https://doi.org/10.1016/S1369-7021(03)01223-9)
- Babin, B. J., & Darden, W. R. (1996). Good and bad shopping vibes: Spending and patronage satisfaction. *Journal of Business Research*, 35 (3), 201-206. [https://doi.org/10.1016/0148-2963\(95\)00125-5](https://doi.org/10.1016/0148-2963(95)00125-5)
- Baker, J., Levy, M., & Grewal, D. (1992). An Experimental Approach to Making Retail Store Environmental Decisions. *Journal of Retailing*, 68 (4), 445-460.
- Banse, R., & Scherer, K. R. (1996). Acoustic Profiles in Vocal Emotion Expression. *Journal of Personality and Social Psychology*, 70(3), 614–636. <https://doi.org/10.1037/0022-3514.70.3.614>
- Barone, M. J., Miniard, P. W., & Romeo, J. B. (2000). The Influence of Positive Mood on Brand Extension Evaluations. *Journal of Consumer Research*, 26 (4), 386-400. <https://doi.org/10.1086/209570>

- Barone, S., Lombardo, A., & Tarantino, P. (2009). Analysis of User Needs for the Redesign of a Postural Seat System. In P. Erto (Ed.), *Statistics for Innovation: Statistical Design of ``Continuous'' Product Innovation* (pp. 3–25). Milano: Springer Milan. [https://doi.org/10.1007/978-88-470-0815-1\\_1](https://doi.org/10.1007/978-88-470-0815-1_1)
- Bartlett, M. S., Littlewort, G., Fasel, I., & Movellan, J. R. (2003). Real Time Face Detection and Facial Expression Recognition: Development and Applications to Human Computer Interaction. *IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops*, 5, 53. <https://doi.org/10.1109/CVPRW.2003.10057>
- Belbin, R. Meredith (1996), *Team roles at work*, Butterworth Heinemann, Oxford.
- Belbin, R.M. (1991). Design Innovation and the TEAM. *Design Management Journal (Former Series)*, 2(3), 38-42.
- Bellizzi, J., & Hite, R. (1992). Environmental Color, Consumer Feelings, and Purchase Likelihood. *Psychology & Marketing*, 9 (5), 347-363.
- Bentley, T., Johnston, L., & Baggo, K. Von. (2005). Evaluation Using Cued-Recall Debrief To Elicit Information About a User ' S Affective Experiences. *Proceedings of OZCHI 2005*, 1–10.
- Bezerra, F. N., Silva, T. M. da, & Ramos, V. P. (2012). Occupational stress of nurses in emergency care: an integrative review of the literature. *Acta Paulista de Enfermagem*, 25 (spe2), 151-156. <https://doi.org/10.1590/s0103-21002012000900024>
- Bitner, M. J. (1992). Servicescapes: The Impact of Physical Surroundings On Customers and Employees. *Journal Of Marketing*, 56, 57-71. Retrieved from <http://www.ida.liu.se/~steho87/und/htdd01/9208310667.pdf>
- Bloch, P. H. (1995). Seeking the Ideal Form: Product Design and Consumer Response. *Journal of Marketing*, 59 (3), 16. <https://doi.org/10.2307/1252116>
- Bonapace, L. (2002). Linking Product Properties to Pleasure: The Sensorial Quality Assessment Method\_SEQUAM.
- Bongard-Blanchy, K., Bouchard, C., & Aoussat, A. (2013). Limits of Kansei - Kansei Unlimited. *International Journal of Affective Engineering*, 12(2), 145–153. <https://doi.org/10.5057/ijae.12.145>
- Bradley, M., & Lang, P. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, 25 (1), 49-59. [https://doi.org/10.1016/0005-7916\(94\)90063-9](https://doi.org/10.1016/0005-7916(94)90063-9)

- Bradley, M., & Lang, P. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, 25(1), 49–59. [https://doi.org/10.1016/0005-7916\(94\)90063-9](https://doi.org/10.1016/0005-7916(94)90063-9)
- Britton, J. W., Frey, L. C., Hopp, J. L., Korb, P., Koubeissi, M. Z., Lievens, W. E., ... St. Louis, E. K. (2016). *Electroencephalography (EEG): An Introductory Text and Atlas of Normal and Abnormal Findings in Adults, Children, and Infants*. Mayo Clinic College of Medicine, Rochester, Minnesota: American Epilepsy Society, Chicago. Retrieved from <http://europepmc.org/abstract/MED/27748095>
- Bruner, G. (1990). Music, Mood, and Marketing. *Journal of Marketing*, 54(4), 94-104.
- Bynion, T.-M., & Feldner, M. T. (2017). Self-Assessment Manikin. In V. Zeigler-Hill & T. K. Shackelford (Eds.), *Encyclopedia of Personality and Individual Differences* (pp. 1–3). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-319-28099-8\\_77-1](https://doi.org/10.1007/978-3-319-28099-8_77-1)
- Calvo, R. A., & D’Mello, S. (2010). Affect detection: An interdisciplinary review of models, methods, and their applications. *IEEE Transactions on Affective Computing*, 1(1), 18–37. <https://doi.org/10.1109/T-AFFC.2010.1>
- Campbell, A., & Pisterman, S. (1996). A fitting approach to interactive service design: The importance of emotional needs. *Design Management Journal (Former Series)*, 7 (4), 10-14.
- Carlson, R. A. (1997). *Experienced cognition*. Lawrence Erlbaum Associates, Inc. Mahwah, NJ.
- Carvalho, M. A. (2009). Effective new product ideation: IDEATRIZ methodology. *IFIP Advances in Information and Communication Technology* 304, 127–140. [https://doi.org/10.1007/978-3-642-03346-9\\_14](https://doi.org/10.1007/978-3-642-03346-9_14)
- Cecchinato, M. E., Cox, A. L., & Bird, J. (2015). Smartwatches: the Good, the Bad and the Ugly? CHI'15 Extended Abstracts, 2133–2138. <https://doi.org/10.1145/2702613.2732837>
- Chakravarthy, B. (n.d.): Design Course on Form: Shape of the Things. <http://www.dsource.in/course/form/emotive-form-generation>, [Accessed on 2021, 25 January].
- Chang, W. C., & Wu, T. Y. (2007). Exploring types and characteristics of product forms. *International Journal of Design*, 1 (1), 3-13.
- Chang, W. Y., & Chang, I. Y. (2014). The influences of humorous advertising on brand popularity and advertising effects in the tourism industry. *Sustainability (Switzerland)*, 6 (12), 9205-9217. <https://doi.org/10.3390/su6129205>
- Chang. (2018). Application of Interaction Design on Visual Communication Design (pp. 79-82). <https://doi.org/10.25236/icemit.2018.052>

- Chebat, J. C., & Morrin, M. (2007). Colors and cultures: Exploring the effects of mall décor on consumer perceptions. *Journal of Business Research*, 60 (3), 189-196. <https://doi.org/10.1016/j.jbusres.2006.11.003>
- Christensen, B. T., & Schunn, C. D.(2007). The relationship of analogical distance to analogical function and preinventive structure: The case of engineering design. *Memory and Cognition* 35(1), 29–38. <https://doi.org/10.3758/BF03195939>
- Coates, D. (2002). *Watches Tell More Than Time: Product Design, Information, and the Quest for Elegance* . McGraw-Hill Education.
- Creusen, M. (1998). *Product appearance and consumer choice* . Delft University of Technology, Delft.
- Crilly, N., Maier, A., & Clarkson, P. J. (2008). Representing artefacts as media: Modelling the relationship between designer intent and consumer experience. *International Journal of Design*, 2 (3), 15-27.
- Crippa, G., Rognoli, V., & Levi, M. (2012). Materials and emotions: A study on the relations between materials and emotions in industrial products. In J. Brassett, J. McDonnell, & M. Malpass (Eds.), *8th International Conference on Design and Emotion (Vol. 3)*. Central Saint Martins College of Art & Design.
- Crippa, G., Rognoli, V., & Levi, M. (2012). Materials and emotions: A study on the relations between materials and emotions in industrial products. In J. Brassett, J. McDonnell, & M. Malpass (Eds.), *8th International Conference on Design and Emotion (Vol. 3)*. Central Saint Martins College of Art & Design.
- Critchley, H. D. (2002). Review: Electrodermal Responses: What Happens in the Brain. *The Neuroscientist*, 8(2), 132–142. <https://doi.org/10.1177/107385840200800209>
- Curralló, A. F. (2017). Emotive Form Design: New Trends and Issues. In: *Proceedings on Humanities and Social Sciences* 4(11), pp. 205–213. <https://doi.org/10.18844/prosoc.v4i11.2876>
- Czerwinski, M., Horvitz, E., & Cutrell, E. (2001). Subjective Duration Assessment: an Implicit Probe for Software Usability. *Proceedings of IHM-HCI 2001 Conference*, 2(November 2003), 160–170.
- Damasio, A. (1999). *The Feeling of What Happens*. Mariner Books.
- Demir, E. (2008). The field of design and emotion: Concepts, arguments, tools, and current issues. *METU Journal of the Faculty of Architecture*, 25(1), 135–152.

- Desmet, P. (2003a). A Multilayered Model of Product Emotions. *The Design Journal*, 6 (2), 4-13.  
<https://doi.org/10.2752/146069203789355480>
- Desmet, P. (2003b). Measuring Emotion: Development and Application of an Instrument to Measure Emotional Responses to Products. In M. A. Blythe, A. F. Monk, K. Overbeeke, & P. C. Wright (Eds.), *Funology: from usability to enjoyment* (pp. 111-123). Dordrecht: Kluwer Academic Publishers. [https://doi.org/10.1007/978-3-319-68213-6\\_25](https://doi.org/10.1007/978-3-319-68213-6_25)
- Desmet, P. M. A., Porcelijn, R., & van Dijk, M. B. (2007). Emotional Design; Application of a Research-Based Design Approach. *Knowledge, Technology & Policy*, 20(3), 141–155.  
<https://doi.org/10.1007/s12130-007-9018-4>
- Desmet, P., & Hekkert, P. (2009). Design & Emotion. *International Journal of Design*, 3 (2), 1-6.
- Desmet, P. (2002). *Designing Emotions*. Delft: Pieter Desmet.
- Donovan, R., & Rossiter, J. (1982). Store atmosphere: an environmental psychology approach. *Journal of Retailing*, 58 (1), 34-57.
- Donovan, Robert, Rossiter, J., Marcoolyn, G., & Nesdale, A. (1994). Store atmosphere and purchasing behavior. *Journal of Retailing*, 70 (3), 283-294. <https://doi.org/10.1037/00332909.126.1.78>
- Dzedzickis, A., Kaklauskas, A., & Bucinskas, V. (2020). Human emotion recognition: Review of sensors and methods. *Sensors (Switzerland)*, 20 (3). <https://doi.org/10.3390/s20030592>
- Dzedzickis, A., Kaklauskas, A., & Bucinskas, V. (2020). Human emotion recognition: Review of sensors and methods. *Sensors (Switzerland)*, 20(3). <https://doi.org/10.3390/s20030592>
- Egger, M., Ley, M., & Hanke, S. (2019). Emotion Recognition from Physiological Signal Analysis: A Review. *Electronic Notes in Theoretical Computer Science*, 343, 35–55. <https://doi.org/10.1016/j.entcs.2019.04.009>
- Ekman, P. (1992). An Argument for Basic Emotions. *Cognition & Emotion*, 6(3-4), 169-200.  
<https://doi.org/10.1080/02699939208411068>
- Ekman, P., & Davison, R. (Eds.). (1994). Moods, emotions, and traits. In *The Nature of Emotion: Fundamental Questions* (pp. 56-58). Oxford: Oxford University Press.
- Farooq, R. (2017). A framework for identifying research gap in social sciences: evidence from the Past.
- Frijda, N. (1994). Varieties of Affect: Emotions and Episodes, Moods, and Sentiments. In P. Ekman & R. Davison (Eds.). *The Nature of Emotion: Fundamental Questions* (pp. 59-67). Oxford: Oxford University Press.

- Frijda, N. H. (1993). Moods, emotion episodes, and emotions. In *Handbook of emotions* . (pp. 381- 403). New York, NY, US: The Guilford Press.
- Gaver, W. (1999). Irrational aspects of technology: Anecdotal evidence.pdf. In C. J. Overbeeke & P. Hekkert (Eds.), *Proceedings of the 1st International Conference on Design and Emotion* (pp. 47-54). Delft.
- Giannini, F., & Monti, M. (2002, July). Shape, Geometer and Aesthetics. *ERCIM News* , (50).
- Gonzalez, I., Val, E., Justel, D., & Iriarte, I. (2017). A Framework for Product Design Based On Semantic Attribution Process. *The Design Journal* 20(sup1), S16–S27 . <https://doi.org/10.1080/14606925.2017.1352983>
- Gonzalez, I., Val, E., Justel, D., & Iriarte, I. (2017). A Framework For Product Design Based On Semantic Attribution Process. *The Design Journal*, 20 (sup1), S16-S27. <https://doi.org/10.1080/14606925.2017.1352983>
- Gonzalez, I., Val, E., Justel, D., & Iriarte, I. (2017). A Framework For Product Design Based On Semantic Attribution Process. *The Design Journal*, 20(sup1), S16–S27. <https://doi.org/10.1080/14606925.2017.1352983>
- Gorn, G. J., Goldberg, M. E., & Basu, K. (1993). Mood, Awareness, and Product Evaluation. *Journal of Consumer Psychology*, 2 (3), 237-256. [https://doi.org/10.1016/S1057-7408\(08\)80016-2](https://doi.org/10.1016/S1057-7408(08)80016-2)
- Gorp, T., & Adams, E. (2012). *Design for Emotion* . Elsevier. <https://doi.org/10.1016/C2010-0-67661-9>
- Goshvarpour, A., Abbasi, A., & Goshvarpour, A. (2017). An Emotion Recognition Approach based on Wavelet Transform and Second-Order Difference Plot of ECG. *Journal of AI and Data Mining*, 5(2), 211–221.
- Graduate School of Engineering and Sciences of Izmir Institute of Technology.
- Green, L., & Bonollo, E. (2004). The importance of Design methods to student industrial designers. *Global Journal of Engineering Education*, 8(2), 175–182.
- Haag, A., Goronzy, S., Schaich, P., & Williams, J. (2004). Emotion recognition using bio-sensors: First steps towards an automatic system. *Lecture Notes in Artificial Intelligence (Subseries of Lecture Notes in Computer Science)*, 3068, 36–48. [https://doi.org/10.1007/978-3-540-24842-2\\_4](https://doi.org/10.1007/978-3-540-24842-2_4)
- Hampton, D. (2015). What's The Difference Between Feelings And Emotions? Retrieved June 20, 2019, from <https://www.thebestbrainpossible.com/whats-the-difference-between-feelings-andemotions/>

- Hayes-Roth, B., Ball, G., Lisetti, C., Picard, R. W., & Stern, A. (1998). Panel on affect and emotion in the user interface. In *International Conference on Intelligent User Interfaces* (pp. 91-94). New York: ACM Press. <https://doi.org/10.1145/268389.268406>
- Hekkert, P., & Desmet, P. (2002). The Basis of Product Emotions. In W. S. Green & P. Jordan (Eds.), *Pleasure with Products, beyond usability* (pp. 60-68). London: Taylor & Francis. <https://doi.org/10.1201/9780203302279.ch4>
- Hilton, K. (2008). Reliability of emotional responses to material textures. *International Design Conference*, 19-22. Retrieved from [http://nrl.northumbria.ac.uk/72/1/TDS\\_Emo.pdf](http://nrl.northumbria.ac.uk/72/1/TDS_Emo.pdf)
- Hirschman, E. C., & Holbrook, M. B. (1982). Hedonic Consumption: Emerging Concepts, Methods and Propositions. *Journal of Marketing*, 46 (3), 92-101.
- Hsu, S. H., Chuang, M. C., & Chang, C. C. (2000). A semantic differential study of designers' and users' product form perception. *International Journal of Industrial Ergonomics*, 25 (4), 375-391. [https://doi.org/10.1016/S0169-8141\(99\)00026-8](https://doi.org/10.1016/S0169-8141(99)00026-8)
- Isbister, K., Höök, K., & Laaksolahti, J. (2006). The Sensual Evaluation Instrument : Developing an Affective Evaluation Tool. In *CHI 2006*. Montréal, Québec, Canada. <https://doi.org/10.1145/1124772.1124946>
- Isbister, K., Höök, K., Laaksolahti, J., & Sharp, M. (2007). The sensual evaluation instrument: Developing a trans-cultural self-report measure of affect. *International Journal of Human Computer Studies*, 65 (4), 315-328. <https://doi.org/10.1016/j.ijhcs.2006.11.017>
- Isbister, K., Höök, K., Laaksolahti, J., & Sharp, M. (2007). The sensual evaluation instrument: Developing a trans-cultural self-report measure of affect. *International Journal of Human Computer Studies*, 65(4), 315–328. <https://doi.org/10.1016/j.ijhcs.2006.11.017>
- Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, 52 (6), 1122-1131. <https://doi.org/10.1037/0022-3514.52.6.1122>
- Isomursu, M., Tahti, M., Vainamo, S., & Kuutti, K. (2007). Experimental evaluation of five methods for collecting emotions in field settings with mobile applications, 65, 404–418. <https://doi.org/10.1016/j.ijhcs.2006.11.007>
- Izard, C. E. (1977). Human emotions. *Nebraska Symposium on Motivation* . Nebraska Symposium on Motivation (Vol. 26). Springer US.
- Izard, C. E. (2009). Emotion theory and research: Highlights, unanswered questions, and emerging issues. *Annual Review of Psychology*, 60, 1–25. <https://doi.org/10.1146/annurev.psych.60.110707.163539>

- Jacobs, J. (1999). How to teach, design, produce and sell product - related emotions.pdf. In C. J. Overbeeke & P. Hekkert (Eds.), *Proceedings of the 1st International Conference on Design and Emotion* (pp. 9-14). Delft.
- Jacobs, J. (1999). How to teach, design, produce and sell product - related emotions. In: C. J. Overbeeke & P. Hekkert (Eds.), *Proceedings of the 1st International Conference on Design and Emotion*, pp. 9–14. Delft
- Jansson, D. G., Smith, S. M. (1991). Design fixation. *Design Studies* 12(1), 3–11
- Jennings, M. (2000). Theory and models for creating engaging and immersive ecommerce websites. *Proceedings of the ACM SIGCPR Conference*, 77-85. <https://doi.org/10.1145/333334.333358>
- Jordan, P. (1998). Human factors for pleasure in product use. *Applied Ergonomics*, 29 (1), 25-33. [https://doi.org/10.1016/S0003-6870\(97\)00022-7](https://doi.org/10.1016/S0003-6870(97)00022-7)
- Jordan, P. (2000). *Designing Pleasurable Products: An Introduction to the New Human Factors*. 1st edn. CRC Press, London <https://doi.org/10.4324/9780203305683>
- Jordan, P. (2005). *Designing Pleasurable Products (First)*. Taylor & Francis e-Library.
- Juran, J., & Godfrey, A. (1998). *Juran's Quality Handbook*. McGraw-Hill (5th Edition). New York.
- Karana, E., Hekkert, P., & Kandachar, P. (2009). Meanings of materials through sensorial properties and manufacturing processes. *Materials and Design*, 30(7), 2778-2784. <https://doi.org/10.1016/j.matdes.2008.09.028>
- Karlsson, B. S. A., Aronsson, N., & Svensson, K. A. (2003). Using semantic environment description as a tool to evaluate car interiors. *Ergonomics*, 46(13–14), 1408–1422. <https://doi.org/10.1080/00140130310001624905>
- Kim, D., & Boradkar, P. (2002). Sensibility Design. *Proceedings of the IDSA National Design Education Conference*, 17-20. Retrieved from [syncii://Kim 2002.pdf](http://syncii://Kim 2002.pdf)
- Kim, J., & André, E. (2008). Emotion recognition based on physiological changes in music listening. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 30(12), 2067–2083. <https://doi.org/10.1109/TPAMI.2008.26>
- Kuesten, C., Chopra, P., Bi, J., & Meiselman, H. L. (2014). A global study using PANAS (PA and NA) scales to measure consumer emotions associated with aromas of phytonutrient supplements. *Food Quality and Preference*, 33, 86–97. <https://doi.org/10.1016/j.foodqual.2013.11.004>
- Küller, R. (1975). *Semantisk miljöbeskrivning (SMB)* (6th ed.). Stockholm.
- Kumar, J. S. (2017). The Psychology of Colour Influences Consumers' Buying Behaviour - A Diagnostic Study. *Ushus - Journal of Business Management*, 16 (4), 1-13. <https://doi.org/10.12725/ujbm.41.1>

- Kunnanatt, J. T. (2004). Emotional intelligence: The new science of interpersonal effectiveness. *Human Resource Development Quarterly*, 15(4), 489–495. <https://doi.org/10.1002/hrdq.1117>
- Lafrenière, D., Dayton, T., & Muller, M. (1999). Variations of a theme: CARD-based techniques for participatory analysis and design. In: *Conference on Human Factors in Computing Systems*, pp. 151–152. <https://doi.org/10.1145/632716.632807>
- Lauer, D., & Pentak, S. (2012). *Design Basics*. Wadsworth (Eighth). Clark Baxter. <https://doi.org/10.1192/bjp.112.483.211-a>
- Laurans, G., & Desmet, P. M. A. (2017). Developing 14 animated characters for non-verbal self-report of categorical emotions. *Journal of Design Research*, 15(3–4), 214–233. <https://doi.org/10.1504/JDR.2017.089903>
- Leclercq, P., & Heylighen, A. (2002). 5. 8 Analogies per Hour. In: J. S. Gero (Ed.), *Artificial Intelligence in Design '02*, pp. 285–303. Springer, Netherlands. [https://doi.org/10.1007/978-94-017-0795-4\\_14](https://doi.org/10.1007/978-94-017-0795-4_14)
- Levy, M., Weitz, B., & Pandit, A. (2017). *Retailing Management* (8th ed.). McGraw Hill Education.
- Lindgaard, G., Fernandes, G., Dudek, C., & Brown, J. (2006). Attention web designers: You have 50 milliseconds to make a good first impression!. *Behaviour and Information Technology*, 25 (2), 115-126. <https://doi.org/10.1080/01449290500330448>
- Liscombe, J. J. (2007). Prosody and speaker state: Paralinguistics, pragmatics, and proficiency. *ProQuest Dissertations and Theses*, (November), 218. Retrieved from [http://search.proquest.com/docview/304862547?accountid=13042%5Cnhttp://oxfordsfx.hosted.exlibrisgroup.com/oxford?url\\_ver=Z39.88-2004&rft\\_val\\_fmt=info:ofi/t:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Dissertations+%26+Theses+GI](http://search.proquest.com/docview/304862547?accountid=13042%5Cnhttp://oxfordsfx.hosted.exlibrisgroup.com/oxford?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/t:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Dissertations+%26+Theses+GI)
- Lokman, A. M. (2010). *DESIGN & EMOTION : THE KANSEI ENGINEERING* The Definition of Kansei. *Malaysian Journal of Computing*, 1(1), 1–11.
- Lucero, A., & Arrasvuori, J. (2013). The PLEX Cards and its techniques as sources of inspiration when designing for playfulness. *International Journal of Arts and Technology* 6(1), 22–43 <https://doi.org/10.1504/IJART.2013.050688>
- Madden, T. J., Hewett, K., & Roth, M. S. (2000). Managing images in different cultures: A crossnational study of color meanings and preferences. *Journal of International Marketing*, 8 (4), 90-107. <https://doi.org/10.1509/jimk.8.4.90.19795>
- McCarthy, J., & Wright, P. (2004). *Technology as Experience*. Cambridge, Massachusetts: The MIT Press.

- McDonagh-Philp, D., & Lebbon, C. (2000). The Emotional Domain in Product Design. *The Design Journal*, 3(1), 31–43. <https://doi.org/10.2752/146069200789393562>
- McGinn, C., & Kelly, K. (2018). Using the Geneva Emotion Wheel to Classify the Expression of Emotion on Robots. *ACM/IEEE International Conference on Human-Robot Interaction*, 191–192. <https://doi.org/10.1145/3173386.3177058>
- Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology. An approach to environmental psychology*. Cambridge, MA, US: The MIT Press
- Melcer, E., & Isbister, K.(2016). Motion, emotion, and form: Exploring affective dimensions of shape. In: *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16)*. Association for Computing Machinery, pp. 1430–1437. New York, NY, USA <https://doi.org/10.1145/2851581.2892361>
- Ménard, M., Richard, P., Hamdi, H., Daucé, B., & Yamaguchi, T. (2015). Emotion recognition based on heart rate and skin conductance. *PhyCS 2015 - 2nd International Conference on Physiological Computing Systems, Proceedings*, 26–32. <https://doi.org/10.5220/0005241100260032>
- Ménard, M., Richard, P., Hamdi, H., Daucé, B., & Yamaguchi, T. (2015, February). Emotion Recognition based on Heart Rate and Skin Conductance. In *PhyCS* (pp. 26-32). <https://doi.org/10.5220/0005241100260>
- Michlewski, K. (2008). *Uncovering Design Attitude: Inside the Culture of Designers*. *Organization Studies*, 29(3), 373-392.
- Mothersill, P. (2014). *The Form of Emotive Design*. Master's thesis, Massachusetts Institute of Technology. MIT Media Lab.
- Nagamachi, M. (1995). Kansei Engineering : A new ergonomic consumer-oriented technology for product development. *International Journal of Industrial Ergonomics*, 15, 3–11. Retrieved from <https://www.scopus.com/record/display.uri?eid=2-s2.0-0029080101&origin=resultslist&sort=plf-f&src=s&sid=cd43fb1b465505fdf9634bd9e0578a87& sot=autdocs&sdt=autdocs&sl=17&s=AU-ID%287003273393%29&relpos=65&citeCnt=730&searchTerm=>
- Nicholson, J., Takahashi, K., & Nakatsu, R. (1999). Emotion recognition in speech using neural networks. *ICONIP 1999, 6th International Conference on Neural Information Processing - Proceedings*, 2, 495–501. <https://doi.org/10.1109/ICONIP.1999.845644>

- Nicolantonio, M. Di, Bucchianico, G. Di, Camplone, S., & Vallicelli, A. (2016). Visual Pleasantness in Interior Yacht Design: A Case Study of the Pleasure-Based Approach Application. In G. Di Bucchianico, A. Vallicelli, N. A. Stanton, & S. J. Landry (Eds.), *Human Factors in Transportation Social and Technological Evolution Across Maritime, Road, Rail, and Aviation Domains*. CRC Press. <https://doi.org/10.1201/9781315370460-5>
- Norman, D. (2004). *Emotional Design : Why we love (or hate) everyday things* . New York : Basic Books.
- Oliver, R. L. (1993). Cognitive, Affective, and Attribute Bases of the Satisfaction Response. *Journal of Consumer Research*, 20 (3), 418. <https://doi.org/10.1086/209358>
- Omodei, M. M., & McLennan, J. (1994). Studying Complex Decision Making in Natural Settings: Using a Head-Mounted Video Camera to Study Competitive Orienteering. *Perceptual and Motor Skills*, 79(3\_suppl), 1411–1425. <https://doi.org/10.2466/pms.1994.79.3f.1411>
- Osborn, A. (1953). *Applied Imagination: Principles and procedures of creative thinking*. Scribner, New York
- Overbeeke, C. J., & Hekkert, P. (1999). Editorial. In: Overbeeke, C. J., & Hekkert, P. (Eds.) *Proceedings of the 1st International Conference on Design and Emotion*, pp. 5–6. Delft
- Pedro, P., German, B. R., Barbara, C. A., Jhonattan, M., Arturo, M., & Maria, P. R. (2019). Sensing, smart and sustainable product analysis methodology through EEG evaluation. *IFAC-PapersOnLine*, 52 (13), 2378-2383. <https://doi.org/10.1016/j.ifacol.2019.11.562>
- Pedro, P., German, B. R., Barbara, C. A., Jhonattan, M., Arturo, M., & Maria, P. R. (2019). Sensing, smart and sustainable product analysis methodology through EEG evaluation. *IFAC-PapersOnLine*, 52(13), 2378–2383. <https://doi.org/10.1016/j.ifacol.2019.11.562>
- Picard, R. W., & Liu, K. K. (2007). Relative subjective count and assessment of interruptive technologies applied to mobile monitoring of stress. *International Journal of Human Computer Studies*, 65(4), 361–375. <https://doi.org/10.1016/j.ijhcs.2006.11.019>
- Picard, R., & Daily, S. (2005). Evaluating Affective Interactions: Alternatives to Asking What Users Feel. *CHI Workshop on Evaluating Affective ...*, 1–4. Retrieved from [http://mit.sustech.edu/NR/rdonlyres/Media-Arts-and-Sciences/MAS-630Spring-2008/Readings/picard\\_chi2005.pdf](http://mit.sustech.edu/NR/rdonlyres/Media-Arts-and-Sciences/MAS-630Spring-2008/Readings/picard_chi2005.pdf)
- Ploder, A., & Eder, A. (2015). Semantic Differential. In *International Encyclopedia of the Social & Behavioral Sciences: Second Edition* (pp. 563–571). Elsevier Inc. <https://doi.org/10.1016/B978-0-08-097086-8.03231-1>
- Plutchik, R. (1991). *The Emotions*. University Press of America, United Kingdom.

- Rao, D.B. (2010). *Scientific attitude, scientific aptitude and achievement*. Discovery Publishing House.
- Richter, F. The Global Wearables Market Is All About the Wrist. (2018) 20 September. Available: <https://www.statista.com/chart/3370/wearable-device-forecast/> [Accessed on 2021, 31 January].
- Robbins, S., & Judge, T. (2013). *Organizational Behavior* (15th ed.). Prentice Hall.
- Robinson KA, Akinyede O, Dutta T, et al. Framework for Determining Research Gaps During Systematic Review: Evaluation [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2013 Feb. Introduction. Available: <https://www.ncbi.nlm.nih.gov/books/NBK126702/> [Accessed on 2021, 10 January]
- Rognoli, V. (2010). A Broad Survey on Expressive-sensorial Characterization of Materials for Design Education. *METU Journal of Faculty of Architecture*, 27 (2), 287-300. <https://doi.org/10.4305/metu.jfa.2010.2.16>
- Scherer, K. R. (2005). What are emotions? and how can they be measured? *Social Science Information*, 44(4), 695–729. <https://doi.org/10.1177/0539018405058216>
- Scherer, K. R. (2005). What are emotions? and how can they be measured?. *Social Science Information*, 44 (4), 695-729. <https://doi.org/10.1177/0539018405058216>
- Scherer, K. R., Shuman, V., Fontaine, J. R. J., & Soriano, C. (2013). The GRID meets the Wheel: Assessing emotional feeling via self-report. In J. R. J. Fontaine, K. R. Scherer, & C. Soriano (Eds.), *Components of Emotional Meaning: A sourcebook* (pp. 281–298). Oxford: Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199592746.003.0019>
- Schifferstein, H. N. J. (2010). From salad to bowl: The role of sensory analysis in product experience research. *Food Quality and Preference*, 21(8), 1059–1067. <https://doi.org/10.1016/j.foodqual.2010.07.007>
- Schütte, S., Schütte, R., & Eklund, J. (2005). Affective Values of Lift Trucks : an Application of Kansei Engineering. In *Proceedings of QMOD Conference 2005, Italy* : (pp. 897–904). Retrieved from <http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-497>
- Sloman, A. (2002). How Many Separately Evolved Emotional Beasts Live within Us? In R. Trappl, P. Petta, & S. Payr (Eds.), *Emotions in Humans and Artifacts* (pp. 35-114). Cambridge MA: MIT Press. Retrieved from <http://www.cs.bham.ac.uk/research/projects/cogaff/sloman.vienna99.pdf>
- Smith, S. M., Ward, T. B., & Schumacher, J. S. (1993). Constraining effects of examples in a creative generation task. *Memory & Cognition* 21(6), 837–845 <https://doi.org/10.3758/BF03202751>.

- Suk, H.-J., & Irtel, H. (2008). Emotional Response to simple colour stimuli. *Kansei Engineering* Vol.7, 7(2), 181–188.
- The Belbin Team and Bird, V. Belbin and Project Teams. (2018) 20 November. Available: <https://www.belbin.com/resources/blogs/belbin-and-project-teams/> [Accessed on 2021, 25 January].
- Thompson, E. R. (2007). Development and Validation of an Internationally Reliable Short-Form of the Positive and Negative Affect Schedule (PANAS). *Journal of Cross-Cultural Psychology*, 38(2), 227–242. <https://doi.org/10.1177/0022022106297301>
- Tom (2012), "Identifying Gaps in the Literature is a Critical Part of a Review", Available: <http://www.literaturereviewof.com/identifying-gaps.html>. [Accessed on 2021, 22 January]
- Torraco, R. J. (2016, December 1). Writing Integrative Literature Reviews: Using the Past and Present to Explore the Future. *Human Resource Development Review*, 15(4), 404-428. SAGE Publications Ltd. <https://doi.org/10.1177/1534484316671606>
- Tractinsky, N., Katz, A. S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with Computers*, 13 (2), 127-145. [https://doi.org/10.1016/S0953-5438\(00\)00031-X](https://doi.org/10.1016/S0953-5438(00)00031-X)
- Tutssel, G. (2001). But you can judge a brand by its colour. *Brand Strategy*, 25 (153), 8-9.
- Tversky, A. (1972). Elimination by aspects: A theory of choice. *Psychological Review*, 79 (4), 281- 299. <https://doi.org/10.1037/h0032955>
- Tyan-Yu, W., Chueh-Yung, T., & Cian-Yu, S. (2017). Unity enhances product aesthetics and emotion. *International Journal of Industrial Ergonomics*, 59, 92-99. <https://doi.org/10.1016/j.ergon.2017.02.003>
- Udovičić, G., Derek, J., Russo, M., & Sikora, M. (2017). Wearable Emotion Recognition system based on GSR and PPG signals. *MMHealth 2017 - Proceedings of the 2nd International Workshop on Multimedia for Personal Health and Health Care, Co-Located with MM 2017*, 53-59. <https://doi.org/10.1145/3132635.3132641>
- Udovičić, G., Derek, J., Russo, M., & Sikora, M. (2017). Wearable Emotion Recognition system based on GSR and PPG signals. *MMHealth 2017 - Proceedings of the 2nd International Workshop on Multimedia for Personal Health and Health Care, Co-Located with MM 2017*, 53–59. <https://doi.org/10.1145/3132635.3132641>
- Ürgen, C. (2006). The use and importance of emotional design in contemporary design practice .
- Vaidya, G., & Kalita, P. C. (2021). Understanding Emotions and their Role in the Design of Products: An Integrative Review. *Archives of Design Research*, 34 (3), 5-21.

- Villarejo, M. V., Zapirain, B. G., & Zorrilla, A. M. (2012). A stress sensor based on galvanic skin response (GSR) controlled by ZigBee. *Sensors (Switzerland)*, 12(5), 6075–6101. <https://doi.org/10.3390/s120506075>
- Warell, A. (2008). Multi-modal visual experience of brand-specific automobile design. *TQM Journal*, 20(4), 356–371. <https://doi.org/10.1108/17542730810881348>
- Watson, D., Clark, L. A., & Tellegen, A. (1988a). Development and validation of brief measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology*, 54(6), 1063–1070.
- Watson, D., Clark, L. A., & Tellegen, A. (1988b). Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology*, 54(6), 1063–1070. <https://doi.org/10.1037/0022-3514.54.6.1063>
- Westbrook, R. A. (1987). Product/Consumption-Based Affective Responses and Postpurchase Processes. *Journal of Marketing Research*, 24 (3), 258. <https://doi.org/10.2307/3151636>
- Westland, S., & Shin, M. J. (2015). The Relationship Between Consumer Colour Preferences and Product-Colour Choices. *Journal of the International Colour Association*, 14, 47-56.
- Williams, C. E., & Stevens, K. N. (1972). Emotions and Speech: Some Acoustical Correlates. *Journal of the Acoustical Society of America*, 52(4B), 1238–1250. <https://doi.org/10.1121/1.1913238>
- Wood, K. L., Linsey, J. S., & Markman, A. B. (2008). Modality and representation in analogy. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing: AIEDAM* 22(2), 85–100. <https://doi.org/10.1017/S0890060408000061>
- Woods, R. (2004). Exploring the emotional territory for brands. *Journal of Consumer Behaviour*, 3 (4), 388-403. <https://doi.org/10.1002/cb.150>
- Yamada, R., Nagai, K., Onishi, H., & Kishimoto, K. (1999). A Method of KANSEI Acquisition to 3D Shape Design and its Application. In *IEEE International Workshop on Robot and Human Interaction*.
- Yu, Y. T., & Dean, A. (2001). The contribution of emotional satisfaction to consumer loyalty. *International Journal of Service Industry Management*, 12 (3), 234-250. <https://doi.org/10.1108/09564230110393239>

## 7 Appendices

### Appendix - A. Creativity Assessment Guidelines

Provided to Evaluators

Instructions

When it comes to evaluating creativity of product ideation, following mentioned factors can be considered.

#### Ideation Quality

The quality of ideas can be measured against the following four factors:

1. Novelty: Novelty is the unusualness or unexpectedness of an idea when compared to other ideas. In other words, novelty is gauging the obviousness of an idea, where non-obvious ideas are considered novel, whereas obvious ideas are non-novel.

(Is the idea uncommon? Does it differ from the expected outcome?)

2. Appropriateness: The idea will be effective in producing desired results if it is suitable for the given situation. In the present study, the appropriateness of an idea would be measured based on its aesthetic appeal as the study primarily targets creativity in formal (related to shapes) idea generation.

(Is the idea relevant to the given context?)

3. Elaboration: It is the ability to detail the idea and appropriately label it for clarity. It is measured based on the amount of detailing done for each attribute of the idea.

(Is the idea detailed out enough for clarity?)

4. Surprise: It is the ability to create something that continues to capture the viewer's eye each time upon revising. An idea having a surprise factor may not be the most novel or original idea, but it may be a combination of obvious ideas in an unexpected way.

(Will the idea surprise you upon revisiting it?)

#### Ideation Variety

Quantity and variety ratings are applicable to an entire group of ideas and not an individual idea.

5. Variety: Variety is measured as the total number of different ideas created by a subject or a group

of subjects in an ideation session. For the current study, any two ideas are considered different if they differ in their embodiment and details.

Note:

Please avoid any bias during the evaluation. Do not judge ideas based on the quality of sketching/presentation. Provide honest ratings considering each idea the same even if it is messy or clear, organized or disorganized, etc.



## Appendix - B. Creativity Evaluation Sheet

How likely is that the given idea possesses following creativity attributes?

	Extremely Unlikely	Unlikely	More or Less Unlikely	Neutral	More or Less likely	Likely	Extremely Likely
Novelty	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
Appropriateness	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
Elaboration	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
Surprise	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
Variety	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

## Appendix - C. Details of Expert Evaluators

<b>Name</b>	<b>Age (years)</b>	<b>Gender</b>	<b>Educational Qualification</b>	<b>Current Organization Name and Location</b>	<b>Total Experience in Design Indus- try/Academia (years)</b>
Patric John	31	M	M.Des.	College of Architecture Trivandrum	6
Ashish Kumar Singh	36	M	Ph.D.	National Institute of Fashion Technology Bhopal	7
Samrat Chatterjee	33	M	M.Des.	TATA Steel, Mumbai	8
Abhishek Anand	31	M	MBA	National Institute of Fashion Technology Bhopal	9
Pankaj Kuli	32	M	M.Des.	Titan Company Ltd.	7

**Appendix - D. Sketches to 3D CAD Renders and Physical Prototypes of Bluetooth Speaker Concepts**

1

T1



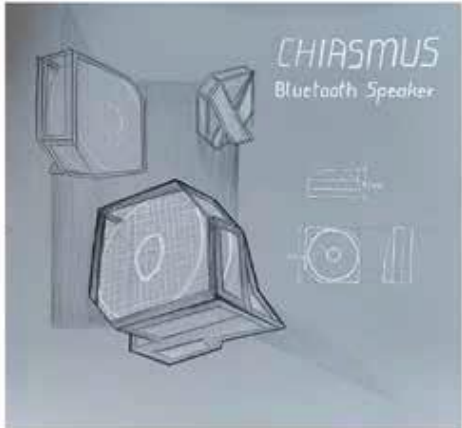
Concept Sketch



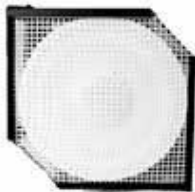
3D CAD Render



T2



Concept Sketch

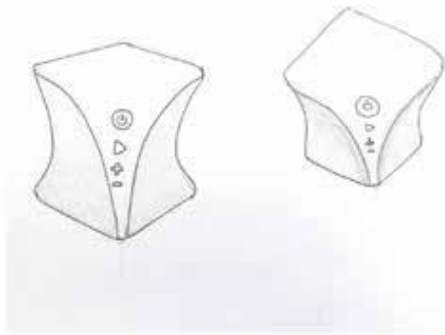


3D CAD Render



2

T1



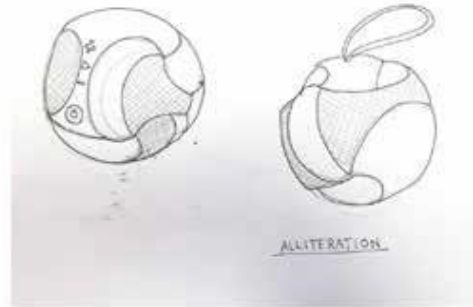
Concept Sketch



3D CAD Render



T2



Concept Sketch

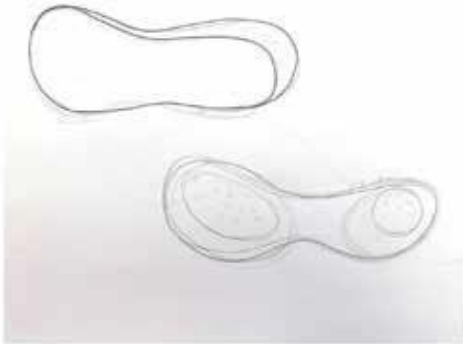


3D CAD Render



3

T1



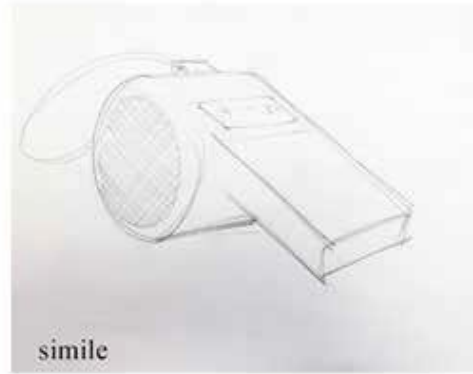
Concept Sketch



3D CAD Render



T2



Concept Sketch

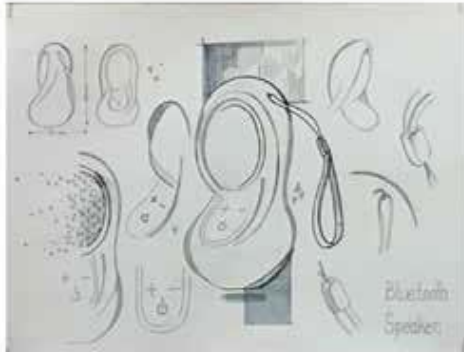


3D CAD Render



4

T1



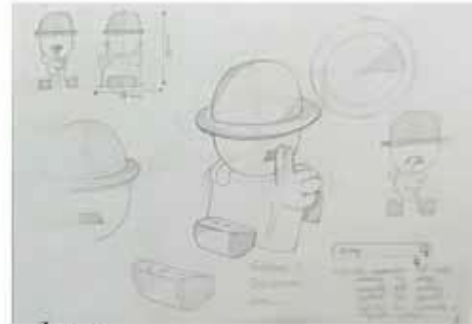
Concept Sketch



3D CAD Render



T2



Irony

Concept Sketch

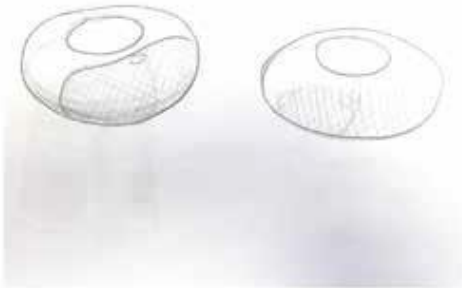


3D CAD Render



5

T1



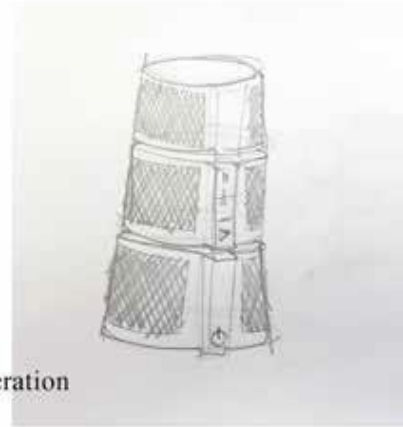
Concept Sketch



3D CAD Render



T2



Alliteration

Concept Sketch



3D CAD Render



6

T1



Concept Sketch



3D CAD Render



T2



Concept Sketch

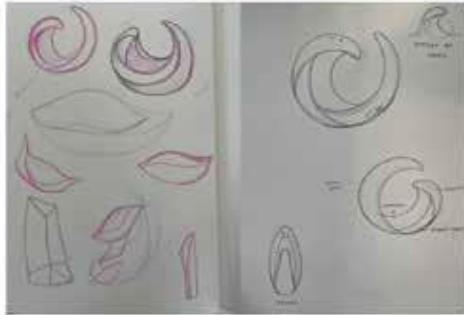


3D CAD Render



7

T1



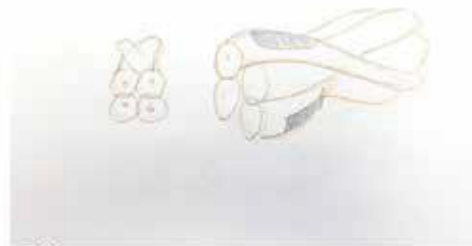
Concept Sketch



3D CAD Render



T2



Chiasmus

Concept Sketch



3D CAD Render



8

T1



Concept Sketch



3D CAD Render



T2



Simile

Concept Sketch

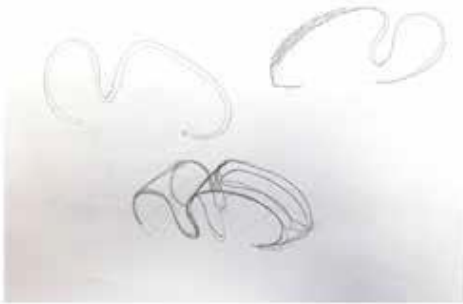


3D CAD Render



9

T1



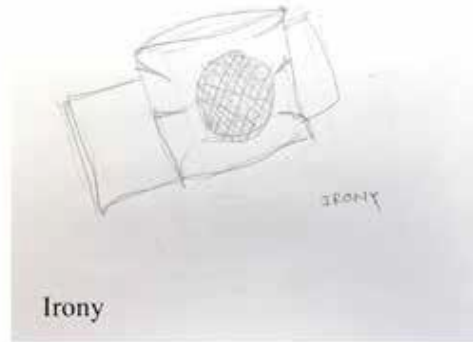
Concept Sketch



3D CAD Render



T2



Concept Sketch

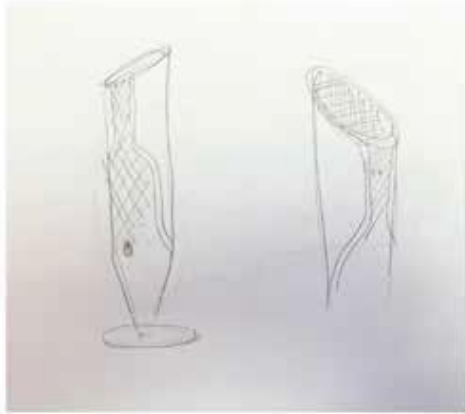


3D CAD Render



10

T1



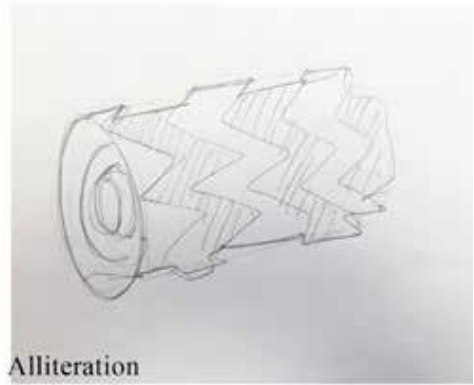
Concept Sketch



3D CAD Render



T2



Alliteration

Concept Sketch

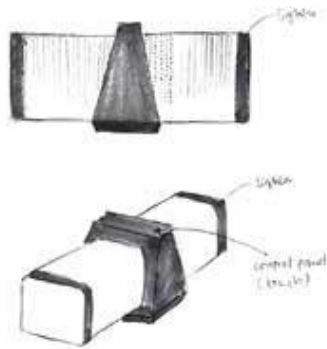


3D CAD Render



11

T1

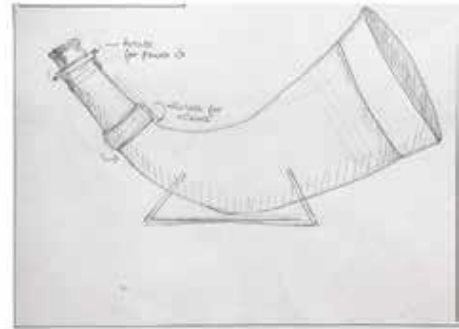


Concept Sketch



3D CAD Render

T2



Simile

Concept Sketch



3D CAD Render

12

T1

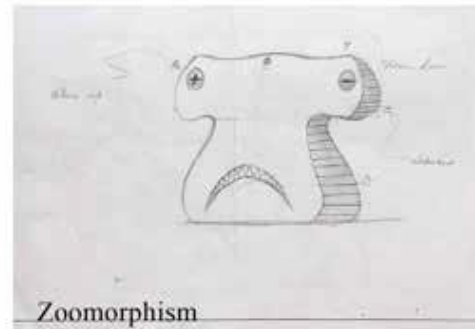


Concept Sketch



3D CAD Render

T2



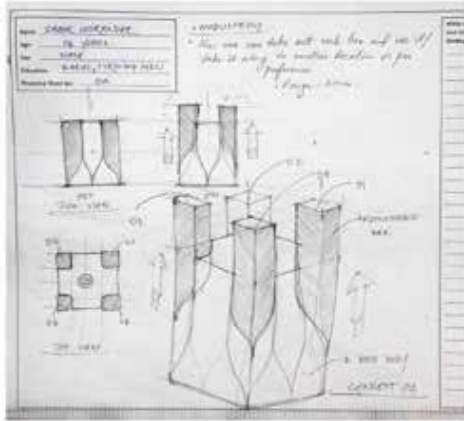
Concept Sketch



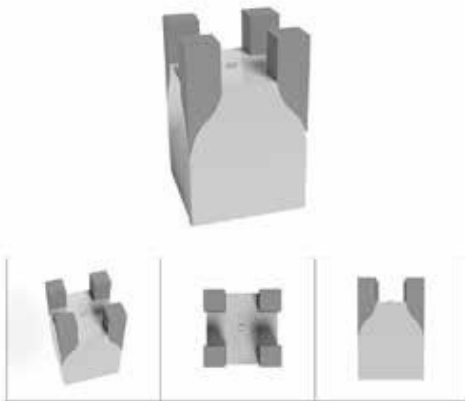
3D CAD Render

13

T1



Concept Sketch



3D CAD Render

T2



Concept Sketch

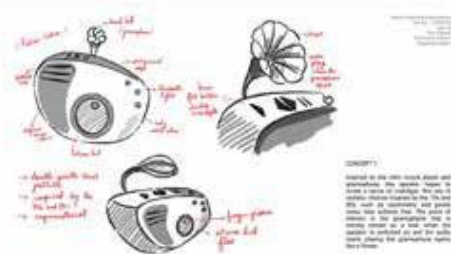


3D CAD Render

14

T1

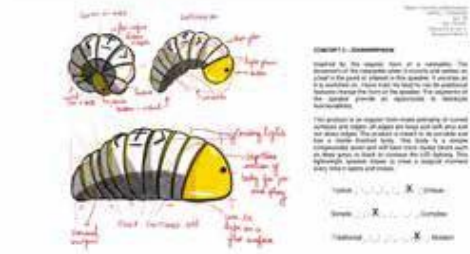
T2



Concept Sketch



3D CAD Render












Zoomorphism

Concept Sketch



3D CAD Render

## Appendix - E. Figures of Speech (FoS) Card Tool

<p><b>IRONY</b></p> <p>Incongruity between what is expected or intended and what actually occurs in terms of form.</p>	 <p>Car Shaped Parking for Bicycle</p>	 <p>Plopp Steel Stool</p>	 <p>Toga Chair</p>
<p><b>HYPERBOLE</b></p> <p>Obvious and intentional exaggeration of an object beyond its normal form.</p>	 <p>Spring Stool</p>	 <p>Pepelkus Outdoor Ashtray</p>	 <p>Drew The Pencil Lamp</p>
<p><b>ZOOMORPHISM</b></p> <p>Giving an object animal like formal qualities or traits.</p>	 <p>Firephant</p>	 <p>Kastor Sharpener</p>	 <p>Woo-bi Lamp</p>

### CHIASMUS

Formal features are structured in reverse/upside down/inside out



UnBRELLA



Garbage Watch



Inside Out Champagne Glasses

### ALLITERATION

Repeating same or similar form module to create the whole object



Chaise Lounge



Love me love me not Table



Sparks Pendant Lighting System

### SIMILE

Comparing forms of two objects which have one or more common characteristics



Sandtime Digital Watch



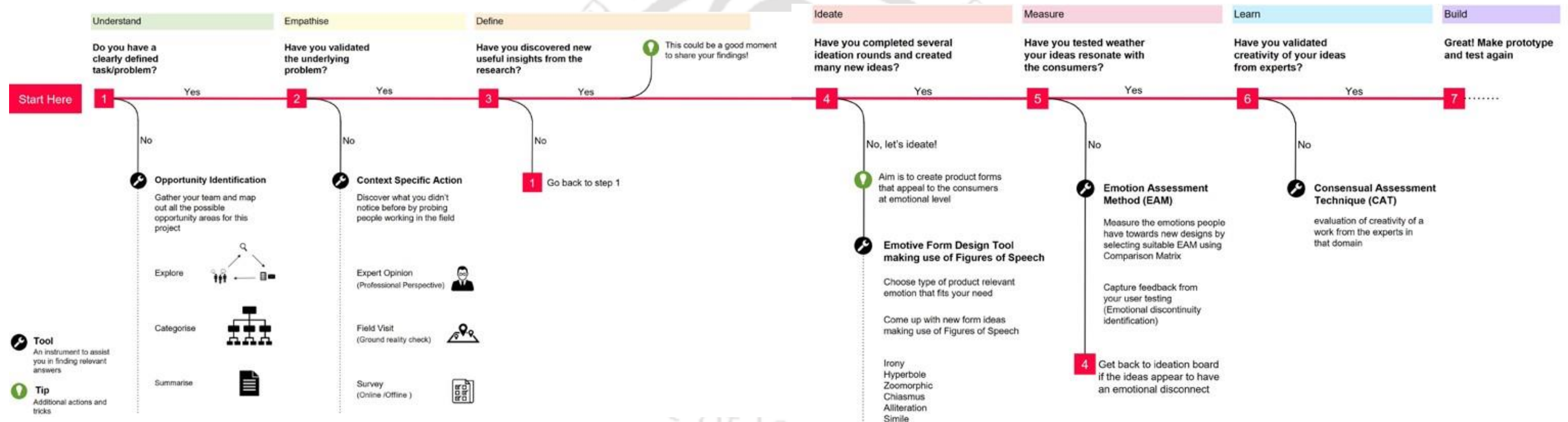
Merlot Chair



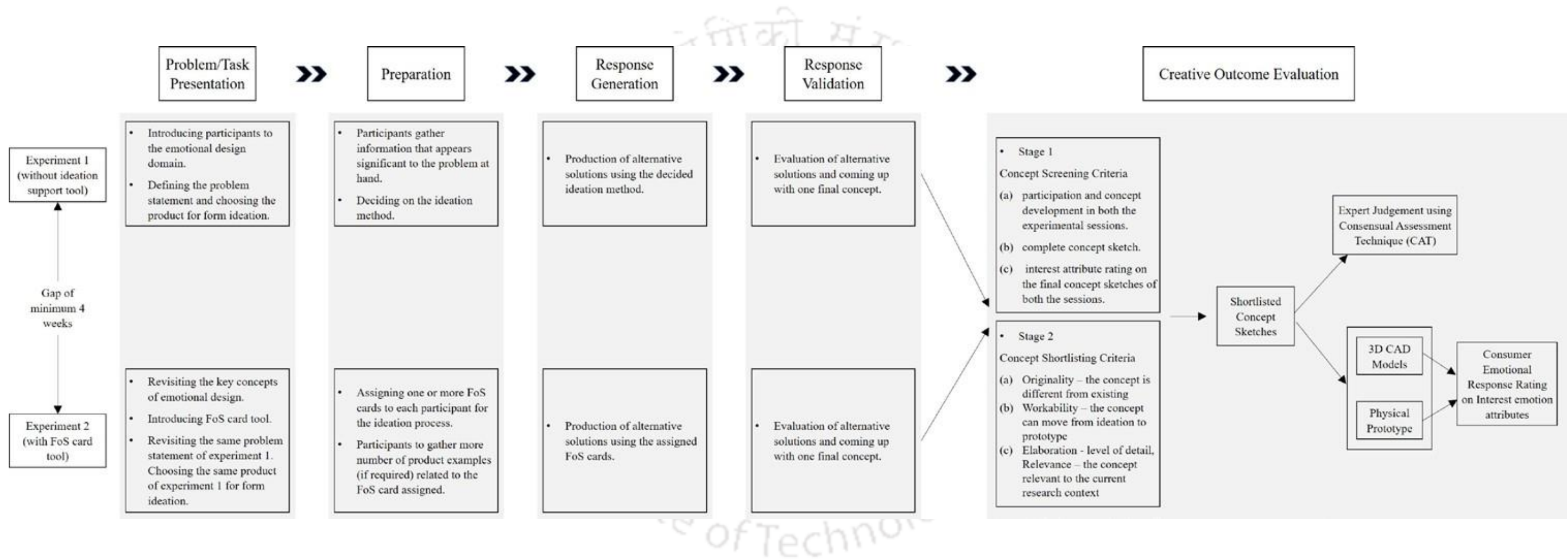
Samurai Umbrella

**Appendix - F. Overall Emotive Form Design Approach using Shaping Emotion Framework and Detailed Protocol of Experiments**

Overall Emotive Form Design Approach using Shaping Emotion Framework



Detailed protocol of experiments



## Appendix - G. List of Publications

### Journal papers

1. **Vaidya, G., & Kalita, P. C. (2021).** Understanding Emotions and their Role in the Design of Products: An Integrative Review. Archives of Design Research, 34 (3), 5-21. [**Scopus Indexed; Q2 Journal**]
2. **Vaidya, Gaurav, and Pratul Chandra Kalita. 2021.** “Emotion Assessment Methods in the Field of Product Design: A Review.” The International Journal of Design Education 16 (2): 1-19. doi:10.18848/2325-128X/CGP/v16i02/1-19. [**Scopus Indexed; Q2 Journal**]

### Conferences proceedings

1. **Vaidya, G., & Kalita, P. C. (2021).** RESEARCH OPPORTUNITY IDENTIFICATION: A PEDAGOGICAL FRAMEWORK FOR DESIGN RESEARCH. In DS 110: Proceedings of the 23rd International Conference on Engineering and Product Design Education (E&PDE 2021), VIA Design, VIA University in Herning, Denmark. 9th-10th September 2021. [**Scopus Indexed**]
2. **Vaidya, G., & Kalita, P. C. (2022).** Designing for Emerging Aesthetics: Product Semantics Approach to the Design of Smartwatches. DS 118: Proceedings of NordDesign 2022, Copenhagen, Denmark, 16th-18th August 2022, 1-8. [**Scopus Indexed**]
3. **Vaidya, G., & Kalita, P. C. (2023).** Developing an Ideation Method for Emotive Form Design of Products. ICoRD 2023.Springer, Singapore. [**Accepted, Scopus Indexed**] [**Distinguished Paper Award**]
4. **Vaidya, G., & Kalita, P. C. (2023).** A Framework for the Design of Smart Wearable Devices Using Emotional Design Approach. ICoRD 2023.Springer, Singapore. [**Accepted, Scopus Indexed**]
5. **Vaidya, G., & Kalita, P. C.** Design, Emotions, and Theories of Product Emotion. A Review. [**In Process**]

### Workshop Conducted

**Vaidya, G., & Kalita, P. C. (2021).** Application of a Card-based Tool for Emotive Form Ideation based on Figures of Speech in English. ICoRD 2021. 7th - 10th January 2021. IDC School of Design, IIT Bombay.