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# MOVEMENT AND EMOTIONS IN DESIGN: DEVELOPING A FRAMEWORK TO INTEGRATE EMOTIONAL EFFECTS OF MOVEMENT EFFECTIVELY

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**Abstract:**
With the advancement in the field of Product Design, the role of movement as a design attribute has increased significantly in products. Despite this surge, designers lack the tools to evaluate the emotional impact of product movement on users. This paper establishes a framework to assess how different motion attributes in consumer products influence user emotions. The presented framework aims to assist designers in understanding, mapping, and incorporating emotional signals related to product motion during the early stages of product development. The framework thus enhances user experience and contributes to product success. A mixed-methods approach, involving an in-depth literature review and user testing, is employed to develop and validate this framework. A motion-emotion analysis tool is at the core of the framework that evaluates four fundamental elements of movement—flow, speed, space, and shape—across two types of movement: utilitarian (functional) and aesthetic (expressive). The tool enables factorial assessment of movement in products, highlighting how each factor contributes to emotional responses within each movement category. Findings reveal that motion attributes such as speed, space, and shape tend to elicit contrasting emotional effects depending on whether the movement is utilitarian or aesthetic. Interestingly, the element of flow appears to generate consistent emotional responses across both categories. These insights offer a foundational step toward integrating emotional evaluation of motion into product design practice, paving the way for more emotionally resonant and user-centered design outcomes.
**Keywords:** Product movement, Emotional Design, Motion Design, Human-product interaction, utilitarian movement, Consumer response

## 1. INTRODUCTION

Movement holds distinct emotional significance for humans and plays a crucial role in how they perceive and interact with their surroundings. By constantly forming connections and engaging with their environment, humans embody the very essence of what it means to be social animals. They attend to entities, both living and non-living, in their surroundings to evaluate whether they are good or bad, friendly or hostile, beneficial or not, etc. This is something that is embedded in human nature as a result of their history and evolution. They even try to make faces out of abstract shapes around them to connect and relate. Perceiving faces in random shapes is because of a psychological phenomenon called 'pareidolia', where individuals deduce familiar shapes (faces) from abstract ones (Hamilton, 2025; Nathan Caruana & Kiley Seymour, 2021). It is rooted in human social nature to recognize faces, as it is essential for connecting and communicating with other individuals (Liu et al., 2014). When connecting and developing relations within their surroundings, humans are naturally drawn toward living and dynamic creatures rather than static ones. Moving entities attract their attention (Abrams & Christ, 2003). Not only are they attracted to moving things, but also, due to their daily social and cultural interactions and evolutionary history, people identify and characterize moving entities as living beings possessing attributes similar to those of living creatures. Heider & Simmel (1944) explained in their study how observers could perceive animated objects as simple as basic geometric shapes, to be characters with emotions, intentions, and other social traits.

Movement in entities triggers social instincts and emotional responses in humans. Therefore, objects or entities that move partially or completely create strong emotional value for them. One example of this is the formation of close relationships with pets. It is due to the psychological and social factors, i.e., provision of emotional support and companionship, that humans develop good relations with pets (Julius et al., 2012; McConnell et al., 2011). Pet owners try to understand the emotional state of their pets through their bodily movements. Tsai et al. (2020) conducted a study to develop emotion terminology for pets, in which most of the emotion-related signs they compiled were associated with pet movements such as tail wagging, parading, purring, jumping, etc. Pet

movements become a means of communication with the owners because of the absence of verbal language exchange. The emotional bonds formed with pets due to their physical movements show that humans may respond to movement in designed objects. (explained in detail in the literature section). By integrating emotionally engaging interactions in products, deeper connections with users can be developed to significantly improve their overall experience (Nam et al., 2007). Physical movement is one of the dynamic and engaging elements that can assist in constructing long-lasting human product relationships. Users build stronger bonds with products that have movement (automobiles) as compared to static products (chairs, tables).

Mankind is now continuously surrounded by an exceeding number of daily-use objects, so they have more relationships with designed objects and systems than inter-human relations. With this increase in human-product interactions, it is important to identify which products will form lasting relations with humans to create sustainable alliances (Chapman, 2005). The emotional side of a product may be more critical to the product's success than its functional elements (D. Norman, 2007). While several researchers worked on the emotional effects of product elements such as colors, form, shape, structure, etc., very few highlighted the element of movement. Ben Hopson (2009) is among the few people who explicitly used the term 'kinetic design', and pressed on its nature and potential. He said that kinetic design is a specific design approach through which new ways can be explored to improve both the aesthetics and functionality of the movement of existing objects and new product concepts.

With technological advancements in the New Product Development (NPD) process, physical movement is being introduced into products to enrich user interaction and compensate for reduced physical movement. There is a range of models (as described in detail in Table 1), for example, the Circumplex Model of Affect by Russell et al (1980) and the Emotion-Movement Relation Framework by Lee et al (2007). These models analyze the relationship between movement and emotions, but do not provide any detailed explanation or strategic approach for applying movement and emotional values more effectively in the NPD process. Also, there are hardly any models that describe the distinction between functional and aesthetic values of products with respect to movement. Beckley et al (2012) put emotions at the center of the NPD process but failed to present the systematic methods or application of physical movement as an element in design. Therefore, a comprehensive study of movement in products and its categorization into detailed groups is needed to guide a designer in incorporating movement more effectively into products to enhance user experience. The Physical movement component analysis model by Jeon & Jung (2021) attempts to draw a relationship between movement elements (material, volume, path, direction, speed) and human emotions. It analyzes a few product cases; however, the model isn't verified through evaluation by experts or general users. The authors also hint towards the need to draw a distinction between the movement components of products.

We propose a framework to provide Product Designers with a set of tools for the effective integration of movement in design. This framework describes the distinction between product movement types, which are Utilitarian and Aesthetic movements, and explains the emotional impact of movement elements such as speed, flow, shape, and space in the case of both utilitarian and aesthetic movements. The factorial assessment of these elements hasn't been done in the literature based on the distinction between aesthetic and utilitarian movements. In this context, we define the following terms.

***Aesthetic Movement*** refers to motion that evokes sensory or expressive responses in the user. It enhances the perceived character, personality, or emotional tone of the interaction by making the product feel more engaging, alive, or relatable.

***Utilitarian Movement*** refers to a motion that serves a practical, task-oriented purpose within a product or system. It accomplishes a defined operation with minimal distraction or expressiveness.

The proposed framework was validated by a user testing survey that recorded the emotional responses to product movements of both types. Validation results revealed that aesthetic movements, when smooth and repetitive, elicited stronger feelings of calm and attachment compared to abrupt utilitarian movements. The presented framework helps designers working in industry and/or otherwise to understand the emotional aspect of movement and make informed decisions during the NPD process. Creative Industry, design studios, freelance designers, R&D departments of product manufacturing industries, etc., will benefit from this research. Researchers can expand upon the presented knowledge to further investigate the topic.

## 2. LITERATURE REVIEW

To ensure a comprehensive understanding of the emotional impact of motion in product design, a structured literature review was conducted. Databases including Scopus, ScienceDirect, and Google Scholar were searched using key terms such as 'product motion,' 'emotional response,' and 'movement design.' Boolean operators were used to expand and refine results. Studies were included that directly addressed the emotional or perceptual dimensions of motion, the role of emotions in designed products or systems, and the emotional effects of movement in designed objects. After initial screening of 120 articles, 27 were selected for in-depth review. The selected articles were thematically analyzed and categorized into three sections. In the first part of the literature review, the strong relation between movement and human emotions is examined alongside examples of how it has been measured by different researchers over time. The second section is focused more on how product-related emotions have been discussed and gauged by researchers. Finally, the third part attempts to examine the few

studies that measured movement-related emotions in products. A summary of all three parts of the literature review is provided in the table below. The aim of the literature review is to analyze how movement has been conceptualized in literature, with a focus on identifying the core elements that are involved in shaping human emotional responses.

*Table 1: Overview of methods to measure different types of emotions*

| Sr. | Type | Scale/Model Name | Method | Purpose | Emotions evaluated | Reference |
|---|---|---|---|---|---|---|
| 1 | Emotions and Movement Studies | The Circumplex Model | Category-sort task | To situate emotions on a two-dimension circle | Valence of emotions from negative to positive (x-axis) Active/passive emotions (y-axis) | (Russell et al., 1980) |
| | | GEW | Category-sort task | To expand upon the semantic space related to emotions | appraisal dimensions (arrangement of emotions) and the intensity of associated subjective feeling (distance from origin). | (Scherer, 2005) |
| | | Emotion-Movement Relation Framework | Questionnaire & interviews | To express emotions through movements | Based on smoothness, openness and velocity | (Lee et al., 2007) |
| | | Kinesthetic Design Framework | Kinesthetic representation | To develop vocabulary for kinesthetic elements | Embodied emotions e.g., tension, balance, resistance etc. | (Miyoshi, 2018) |
| | | Emotion related signs | Pet owners' self-report (Interviews) | To identify owner vocabulary relating to pet emotions | Negative and Positive emotions in pets | (Tsai et al., 2020) |
| 2 | Product related Emotion Studies | SAM (Self-Assessment Manikin) | Non-verbal Questionnaire | To measure emotions relating to an object/event | 18 bipolar adjective pairs. Pleasure (6), Arousal (6), Dominance (6) | (Bradley & Lang, 1994a) |
| | | Kansei Engineering | Focused Groups | To measure emotions by creating semantic space specific to an object | All possible emotions identified in the semantic space, related to a particular object | (Schütte et al., 2004) |
| | | PrEmo | Animated characters | To measure emotions through bodily expressions and movements | Pleasant-Unpleasant and High Activation-Low Activation | (P. Desmet, 2018) |
| 3 | Product Movement related Emotion Studies | Moving Design | Physical movement imitation | To study emotional impact of movement in objects | Six emotions: Sadness, anger, fear, joy, surprise, attraction | (Weerdesteijn et al., 2005) |
| | | Emotion Palpus | Questionnaire | Generate physical movement to express emotions | Based on smoothness, openness and velocity | (Lee et al., 2007) |
| | | Movement Component Analysis Model | Movement component analysis | To study emotional impact of movement in objects | Form, mechanical and behavioral components | (Jeon & Jung, 2021) |

### 2.1. Movement and Emotions

Movement has a distinct place in human cognition. A mere change in the position of an object (Abrams & Christ, 2003) or any change in the visual field (Karacan & Hayhoe, 2008) attracts attention. Why does motion attract attention? For humans, the reason is that they are wired to detect any movement in the surrounding environment so they can evaluate it and prepare for an appropriate response. Movement plays around with emotions in multiple ways. It triggers emotional responses in observers and drives them to action. In a way, the sudden popping out of bread from a toaster triggers an emotional response from the user. Due to their history and evolution, human beings become conscious of any moving thing around them. Humans have been programmed to perceive moving entities as living creatures because of their encounter with animals throughout history. Heider & Simmel (1944) showed through experimentation how observers could perceive animated objects as simple as basic geometric shapes, to be characters with emotions, intentions, and other life-like attributes. Imagining the front view of a car as a face isn't intentional; it is a natural consequence of our interaction abilities.

Not only do we associate life with moving objects, but also, sometimes, we project our own emotions onto moving things around us. As a result, we experience the phenomenon of Kinesthetic Empathy. When we see a dance performance, we experience the feeling of virtually moving along with the performer. This happens with objects and non-living things as well. Watching a pendulum oscillate gives an observer the sense of virtually moving back and forth. A moving object's ability to generate an empathy-like emotional response becomes a valuable asset in itself. Motion designers can use movement traits like flow, tempo, and direction to create desired emotions. A coffee machine lid opening slowly and smoothly conveys a message of care and creates an emotionally warm interaction. In contrast, a printer that moves its parts with abrupt clicks and stops feels functional but cold.

### *2.1.1. Kinesthetic Empathy*

**Core Element: Kinesthetic Empathy** – the user's emotional resonance with non-human movement.

The constant scrolling on a smartphone, getting hooked on a clip that shows a ball jumping down the stairs in rhythm, the soft sensation of watching drapery dragged smoothly along a staircase in a TV advertisement, or the freshening sensation of watching tree leaves tremble beautifully in a soft breeze are all because of the aesthetics of movement. Whether it is on screen or in the real world, movement attracts, engages, and keeps the curiosity of the observer alive. *But why is movement as engaging as it is?* Human ability to experience the movements and sensations of another person as if they were their own is called Kinesthetic Empathy. 'Kinesthesis' derives from the Greek words kine (movement) and aesthesis (sensation). Miyoshi (2018) explained how we experience it even when we observe non-human moving entities. Through animated prototypes of non-human objects (like rocking cones and balance machines), the study found that participants physically resonated with motion traits such as tension, balance, heaviness, and release. These responses led to the identification of **15 kinesthetic elements**, forming a structured vocabulary to describe and design emotionally expressive movement.

*Figure 1: Miyoshi's Kinesthetic Elements*

### *2.1.2. Gauging Emotions Related to Movement*

**Core Element: Aesthetic Engagement through Rhythmic or Harmonious Movement** – as a source of emotional immersion.

Some key frameworks/models that establish the relation between movement and emotion, developed by various researchers, have been presented here. All these models establish that movement has a strong relationship with emotions.

**The Circumplex Model** by Russell et al (1980) distributes emotions in a circular structure across two dimensions, where the x-axis represents the valence of emotion from negative to positive, and the y-axis shows arousal/activity; how active or passive an emotion is. The horizontal axis (valence) ranges from negative emotions (e.g., depression, fear) to positive emotions (e.g., calmness, delight). The vertical axis differentiates between high-energy emotions like fear or astonishment (active) and low-energy emotions like tiredness or sleepiness (passive). For example, calmness and depression are both low-arousal emotions but differ in valence.

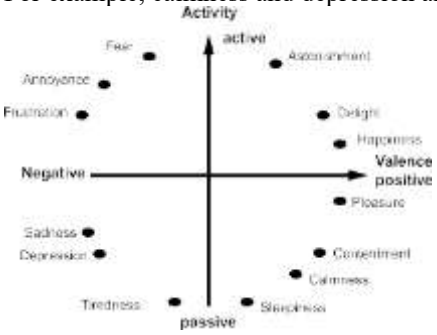


*Figure 2: Circumplex Model*

The special arrangement emphasizes the interconnection and fluid nature of emotions. It also highlights how a single variable, such as product movement, may influence emotional response along one or both dimensions. A fast, jerky motion might push an experience from contentment toward annoyance, while a slow, smooth motion may evoke calmness or sleepiness. The model provides a valuable, interpretive tool for designers and researchers, allowing them to map emotional responses onto a structured emotional space. This helps clarify not just whether a motion is positive or negative, but how and to what extent it activates users emotionally.

**The Geneva Emotion Wheel** by Scherer (2005) presents emotions in a radial layout based on emotional valence (positive to negative) and intensity (represented by size and color intensity). Each emotion appears in varying levels of intensity, with larger, darker circles indicating stronger emotions and smaller, lighter ones indicating mild forms. For example, anger, hostility, and disgust cluster on the negative side and appear in multiple intensities, while satisfaction, pride, and hope appear on the positive side.

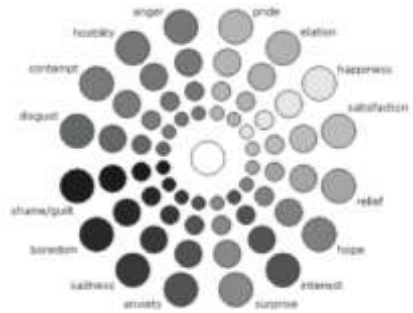


*Figure 3: Geneva Emotion Wheel (GEW)*

The model supports a fine-grained assessment of emotions, useful for user experience testing. When a product movement evokes, for example, mild interest versus intense surprise, this framework helps quantify and compare that response across different motion traits or scenarios.

**The Emotion-Movement Relation Framework** by Lee et al (2007) presents a two-dimensional structure that connects motion qualities, specifically speed, flow, and special openness to emotional responses across axes of valence (pleasantness) and activation (arousal). The vertical axis, which ranges from high arousal at the top to low arousal at the bottom, is linked to speed and openness. Fast and open movements, for example, alert and excited, are associated with high activation states. Slow and closed movements, such as calm and depressed, indicate low activation. The horizontal axis is tied to motion fluidity and ranges from unpleasant (left) to pleasant (right). Jerky movements correspond with negative emotions, e.g., upset or nervous, while smooth motions align with positive affects e.g., serene and relaxed.

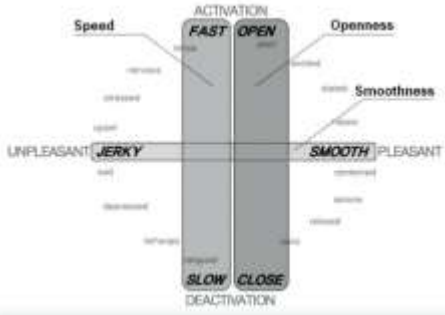


*Figure 4: Emotion-Movement Relation Framework*

Importantly, the model captures bodily states such as tension or fatigue, which are often overlooked in emotion models. Therefore, it adds a kinesthetic layer to the motion-emotion interpretation. For designers, it offers a guide to stimulate emotional tone through movement. A fast, open, and slightly jerky motion in a product can convey a sense of urgency or alertness. A product's slow and smooth motion in a closed space creates a calming experience.

### *2.1.3. Role of movement-related emotions in developing relationships*

**Core Element: Valence-Arousal Axes** – to categorize the emotional impact of product movement types.

Emotions play a significant role in the longevity of all relations. When talking about emotions, there can be many examples of movement-related emotion elicitation. Movement in pets, however, is one example in terms of resulting in positive relationship development. The provision of emotional support and companionship is the reason why humans develop such close relations with pets (Julius et al., 2012; McConnell et al., 2011). Pet movements, in this context, are central to developing these bonds because they serve as a means of communication between the pet and the owner. (Tsai et al., 2020) Conducted a study to put together an emotion vocabulary for pets. Although he didn't point it out, almost all the emotional signs he compiled were related to pet movements,

i.e., purring, jumping, tail wagging, parading, waving, stretching, pacing, etc. These cues are the embodied, nonverbal communication patterns that pets instinctively use to signal their internal states to humans.
In Product Design, movement is a nonverbal interface that can mirror pet behavior to create similar emotional impressions. By translating pet affective movement cues into motion traits of designed objects, products can achieve a form of empathic expressiveness. Just as humans interpret a dog's wagging tail as enthusiasm or a cat's withdrawal as discomfort, they instinctively read motion-based product cues as indicative of a product's mood, state, or intention. Leveraging human ability to read motion patterns as signals of internal states, Tsai's pet emotion cues can be translated into possible motion traits in products. The following is a matrix diagram that links pet movement cues to realizable product motion.

*Table 2: Pet Movement to Product Movement Mapping*

| **Pet Behavior Cue** | **Emotional Meaning** | **Translatable Motion Trait** | **Product Category Application** | **Emotional Effect on User** |
|---|---|---|---|---|
| Tail wagging / body wagging | Excitement, joy | Rhythmic side-to-side swaying or oscillation | Smart speakers, task robots, desk lamps | Perceived happiness, approachability |
| Ears perking up / alertness | Attention, engagement | Subtle lifting or angular tilting | Notification devices, home assistants, camera pods | User feels noticed or acknowledged |
| Pawing / whining | Soliciting interaction | Repetitive micro-movements (e.g., tapping, bouncing) | Alarm clocks, wearable reminders, smart remotes | Urgency with emotional softness |
| Cuddling / licking | Comfort, affection | Smooth folding, wrapping, or soft vibration | Heated blankets, wearables, audio devices | Warmth, trust, bonding |
| Looking away / slinking | Rejection, unease | Receding movement, dimming light, withdrawal | Smart displays, personal assistants | Signals disengagement or need for attention |
| Picking up favorite toys | Playfulness, gift-giving | Revealing features or popping gestures | Food dispensers, cosmetic devices, toolkits | Surprise, delight, emotional novelty |
| Pacing around / parading | Displaying attention-seeking | Circling motions, LED chasing lights | Fitness trackers, gaming controllers, desk toys | Captures attention, energizes interaction |
| Laying down / hiding face | Sadness, shutdown | Full-body stillness or closing-in motion | Battery-depleted signals, sleep-mode indicators | Softly communicates fatigue, encourages empathy |
| Stretching | Relaxation, emotional reset | Elongating or arcing movement | Sleep tech, posture sensors, massagers | Calm, physical-emotional well-being |

## 2.2. Emotions and Product Design

### *2.2.1. Role of Emotional Communicators*

**Core Element: Non-verbal Movement Cues as Emotional Communicators** – a designable interaction layer.
The secret code of design is Emotion (Mareike Roth, 2022). Just as humans intuitively respond to movement cues, they are also influenced by products that are emotionally expressive. The concept of emotions in Product Design has been gradually adopted by researchers and designers. Hartmut Esslinger coined the guiding principle "Form follows emotion" in the 1980s. The pivotal published work in this regard is that of Norman (2007), who suggested that the emotional side may be more critical than the functional parts of a product. Any product elicits emotions, whether or not the designer intended for it to happen or is even conscious of it (P. M. A. Desmet, 2008). Emotions, elicited by products, are not only important at the buying stage but also during their usage and disposal. Products evoke all kinds of emotions in people, for example, wonder or admiration while looking at them, joy when they purchase, disgust or rapture during their usage, and even when they discard a product, they might experience emotions of sadness or guilt, etc.
Emotional Design is not just effective but instrumental in functionality perception. Products that are designed using principles of Emotional Design are not only aesthetically pleasing but functional as well (Yusa et al., 2023). Emotions are believed to be pivotal in the success of a product. Norman (2007) highlighted 3 processing levels of human cognition, and with these three levels, he associated the three emotional levels. The lowest level of processing is Visceral, where the aesthetics of a product play an important role. The behavioral level comes in the middle and deals with the functionality of the products. The Reflective level is the highest level of processing, where the user reflects and evaluates a product. At this level, the quality of the relationship between the user and the product is determined. The following is a visual representation of the three processing levels that Norman described.

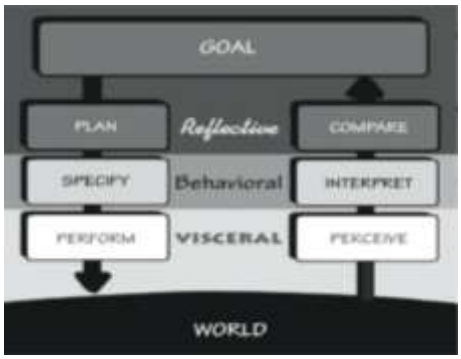

*Figure 5: Levels of processing*

### *2.2.2. Role of Emotions in Human-Product Relations*

**Core Element: Three-Level Emotional Processing (Visceral–Behavioral–Reflective)** – as a framework for situating product movement.

Today, mankind is fated to develop connections with the abundant supply of man-made objects and systems more than inter-human relations (Chapman, 2005). It is important for both the makers and users of products to identify which ones will form lasting relationships to create sustainable alliances between users and objects. Emotions can play a significant role in developing these relations. According to Norman, a good design is created by considering all three levels of processing. It is the third level, reflective, that plays a role in developing long-term relations between users and objects. Reflective design is about long-term relations (D. A. Norman, 2013), so more thought has to be given to this level when opting for a lasting connection between users and products.

At the reflective processing level, as proposed by Norman, emotional responses to products are shaped by personal meaning, cultural association, and memories. Products can transcend from being aesthetically appealing or functional gadgets initially to emotionally charged artifacts with personal narratives later. For example, kinetic artifacts may capture users' attention through fascination at the visceral level, facilitate utility at the behavioral level, and may evoke emotions such as nostalgia, attachment, and pride at the reflective level. These transitions mark a deepening relationship where the product is no longer valued solely for what it does or how it looks, but for what it symbolizes in the user's life. Beyond the point of initial interaction, it is the consideration of the reflective level that assists in emotion sustenance and evolution of product-person bonds

### *2.2.3. Gauging Emotions Related to Products*

**Core Element: Reflective Processing for Lasting Product-User Bonds** – linking movement to identity and narrative.

There are several methods outlined below that have been used to measure product-related emotions. First, there are verbal or self-reporting methods where questionnaires or interviews of the users are conducted to record their emotions related to their experience with products. Then there are methods in which non-verbal ways are used to record emotions. Some of these methods are explained below.

**Kansei Engineering (KE)** is a process of translating user emotions for the development of new product design elements (Schütte et al., 2004). The technique is developed to integrate the emotional aspect into the product design process by understanding user emotions through the creation of relevant vocabulary or semantic space. While it effectively aligns product features to user perceptions, it presents some limitations as well. Firstly, the reliance on linguistic descriptors (Kensei words) may oversimplify complex emotional experiences. Secondly, KE assumes a relatively static relationship between product features and emotional responses, which ignores the dynamic, contextual, and evolving nature of user-product interaction. This becomes a challenge, especially in the context of kinetic products.

**SAM** or the **Self Assessment Manikin** is a type of pictorial questionnaire that examines the emotional states of the user after exposure to an object or event(Bradley & Lang, 1994b). This falls in the category of non-verbal emotion measurement techniques. It measures emotions in 3 dimensions, namely valence, arousal, and dominance. The benefit of this process over verbal assessment is that it is not bound to certain words and can be used cross-culturally.

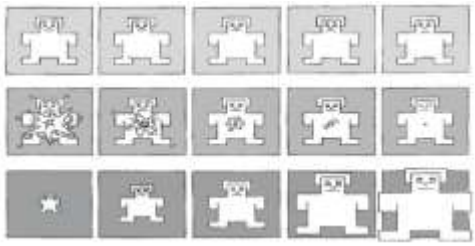
*Figure 6: SAM: Affective dimensions of valence(top), arousal(middle) and dominance(bottom)*

The simplicity, speed, and cross-cultural applicability of SAM are appealing for early-stage product evaluations with diverse user groups. However, as a method for capturing product-related emotions, it has its limitations. One key issue is that it focuses on broad, generalized emotional states, which may not capture the complex, context-dependent feelings evoked by product interaction. The abstract nature of the visual scale can lead to subjective interpretation, potentially affecting reliability.

**The Product Emotion Measurement Instrument (PrEmo),** developed by Desmet (2018), measures product-related emotions through an animated character's facial expressions and bodily movements. It uses a moving image with gradual intensification of bodily expressions, hence more engaging and easier for people across cultures to relate to. One of the core strengths of PrEmo is the use of dynamic, animated expressions rather than static images or verbal scales. The moving visuals enhance emotional relatability by mimicking the expressive cues humans naturally associate with actual emotional states.

The 7 pairs of emotions are carefully selected to reflect emotions that are commonly evoked by products. However, the emotion pairs in PrEmo can be more analytically useful if divided into two categories: *aesthetic emotions* (i.e., fascination-boredom, admiration-contempt), and *functional emotions* (i.e., joy-sadness, satisfaction-anger). By integrating movement-based emotional categories, its utility could be enhanced to better reflect kinetic interactions.

### 2.3. Product Movement and Emotions

**Core Element: Cross-Cultural Emotion Measurement Tools** – guiding validation of emotional responses to product movement.

Movement in design has long been undervalued for its emotional affordance. The primary role of movement in design has been considered functional, but it also gives pleasure, surprise, and enjoyment. Human fantasy in kinetic construction is evident from the scores of mechanical variations in antique clocks (Kensho Miyoshi, 2020). While several researchers worked on the effects of colors, form, shape, structure, etc., on human emotions, product movement and its effects on human emotions is a subject that has not been studied extensively. Ben Hopson (2009) is one of the few people who explicitly used the term 'kinetic design', and pressed on its nature and potential. He said that both the aesthetics and functionality of the movement of existing objects and new product concepts can be improved through a kinetic design approach. Movement in products, whether functional or aesthetic, can activate powerful emotional stimuli, triggering responses ranging from surprise and delight to discomfort and distrust. While static products may evoke emotions like admiration, comfort, or familiarity, the interaction remains largely passive.

#### *2.3.1. Static vs Dynamic Objects*

Static products rely on fixed visual or tactile stimuli to evoke emotions. On the other hand, dynamic products extend emotional communication into the temporal domain. They offer a richer palette of expressions, introducing narrative, anticipation, and feedback. Kinetic objects possess a distinct advantage in generating emotionally rich, immediate, and interactive experiences due to their ability to move and change over time. The following table presents a comparison between the emotionality of static and dynamic products.

*Table 3: Static vs Dynamic Products*

| Aspect | Static Products | Dynamic Products |
|---|---|---|
| Emotional Expression | Limited to visual/formal cues such as color, shape, material, and texture. | Movement (kinetics), timing, rhythm, gesture, responsiveness |
| Emotions Range | Limited: Admiration, calmness, or aesthetic pleasure. | Surprise, playfulness, empathy, companionship (Products can convey intentionality or lifelikeness, deepening emotional engagement). |
| User Interaction | Passive, short and one-directional (e.g., observing or holding the product). | Active interaction: The product reacts or initiates action (e.g., unfolding, rotating) |
| Temporality | Static: Emotion is static and tied to first impressions or symbolism. | Temporal: Temporal dynamics like anticipation, rhythm, and timing, evoking emotions that shift and evolve (e.g., from surprise to delight, or fascination to attachment). |
| Interpretation Dependency | Highly dependent on user's associations, culture and personal meanings. | More universal and immediate due to human sensitivity to movement cues. |
| Memory & Attachment | Emotional attachment forms over prolonged use through memories, usability, or personal relevance. | Accelerate attachment by creating memorable, emotionally charged experiences. Dynamic behavior can simulate companionship or care. |
| Design Strategy | Focuses on form, ergonomics, and symbolism to communicate emotion. | Involves motion design, choreography, and interaction timing to evoke emotion through behavior. |

### 2.3.2. *Gauging Emotions Related to Movement in Products*

**Core Element: Kinetic Design as Emotional Strategy** – movement not only as a function, but form of expression.

Very few researchers have examined the effect of movement in products on human emotions, so this remains an evolving niche within the broader field of affective product design. The few notable studies are explained below. The methods used in these studies range from exploratory and observational studies to design-based research, resulting in motion-specific frameworks.

Weerdesteijn et al (2005) designed movement in objects solely for an emotion study. This was primarily a qualitative study with exploratory and design-based research characteristics. The objects were designed to express six basic emotions like anger, fear, sadness, joy, surprise, and attraction, validated through experimentation with young children between the ages of 4 and 6. The children were asked to detect and express the embodied emotions in products through their own body movements. The experiments were quite successful as children understood and imitated most of the emotions in the six designed objects. The study demonstrated that motion can shape emotional perception in interactive artefacts.

*Limitations*: The primary participants were children, expressing emotions in a learning environment. This makes it hard to extrapolate findings to regular consumer products or adult emotional engagement. Moreover, it did not separate movement parameters such as flow, speed, or path as distinct variables in emotion elicitation.

**Emotion Palpus**

Emotion Palpus is a physical device designed to embed physical motion into products to enhance their emotional utility. The device was developed based on the Emotion-Movement Relationship Framework (described in section 2.1.2). Using the three key movement elements, which are velocity, openness, and smoothness, user studies were conducted to test whether manipulating these parameters influenced emotional valence and activation levels. The strength of Emotion Palpus lies in the actionable parameters it offers for designing emotionally resonant motion in interactive artifacts.

*Limitations*: Emotion Palpus was tested in controlled experimental tasks, and its real-world effectiveness remains uncertain.

**Movement Component Analysis Model**

The movement component analysis model by Jeon & Jung (2021) specifically analyses the movement components in products. The researchers first developed a movement components analysis framework and then examined a few products with movement through it.

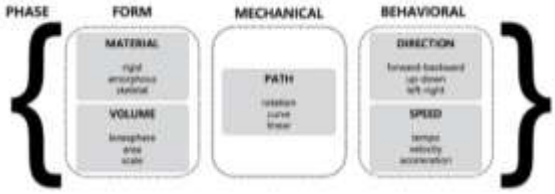


*Figure 7: Movement Component Analysis Model*

The model examines movement components, divided into three phases: form, mechanical, and behavioral phases. The first phase analyzes the materials and volume of the product movement. In the Mechanical phase, the path of motion is analyzed, while in the Behavioral phase, the direction and speed are examined.

*Limitations:* This model was developed based on the existing work; however, the researchers did not opt for its validation through user testing.

The authors of the Movement Component Analysis Model hint towards the need to distinguish the movement components of products; however, they wrongly suggest that this distinction should be drawn between the 'functional' and 'emotional' components of movement. According to the theory of Emotional Design, every aspect of a product has an emotional value, be it the colors, form, material finishes, or even product movements. The functional components are also emotional components because they have an impact on user emotions as well. It is incontrovertible to say that any aspect of a product, let alone motion, becomes emotional when it triggers a response that matters to the user. So, to draw a distinction between functional and emotional components does not make sense. However, to understand the emotional impact of product movement comprehensively, the distinction should be drawn between different types of movement, i.e., utilitarian and aesthetic. Although this division of movement components does not exist in the literature, Hopson (2009) talked about these two types when he said that through kinetic design, both functionality and aesthetics of movement can be improved. Miyoshi (2018) also hinted at this distinction when he said physical movement of products serves either practical or aesthetic purposes.

### 2.3.3. *Product Movement Elements*

**Core Element: Movement Component Analysis (Form–Mechanical–Behavioral)** – as a precursor to defining types and effects of product movement.

(Nam et al., 2007) Included three elements of product movement in his Emotion-Movement Relation Framework: speed, flow, and space. Laban analyzed the emotional effects of movement through four movement elements that are body, effort, shape, and space(De Souza, 2016). (Feijs et al., n.d.) classified the elements of product movement as path, direction, volume, and speed. (Jeon & Jung, 2021) included form (material, volume), mechanical (path), and behavioral (direction, speed) elements in their movement analysis model. The most commonly used factors for emotion evaluation are therefore selected for inclusion in our model. These four parameters possess the essential qualities through which motion is perceived, interpreted, and emotionally evaluated by users during interaction.

**Flow:** Flow is the factor that contributes majorly to shaping the overall perception of a kinetic object. The users immediately notice whether a movement feels abrupt or fluid. A uniform, seamless movement transmits feelings of tranquility, while an interrupted motion evokes a feeling of anxiety and stress. In product design, such variations impact on emotional valence.

**Speed**: One of the most noticeable features of movement is speed. It is the rate of motion over time. A fast motion can raise urgency, aggression or enthusiasm, while a slower movement may be interpreted as hesitation or calm. Speed is critical in measuring emotions through movement because of its impact on the interpretation of product motion.

**Space**: The spatial extent of movement (like how far, wide, close, or expansive motion) is crucial because it influences perception and engagement. The spatial behavior of movement may be interpreted differently for aesthetic and functional movement. A large, open motion may be understood as expressive when the movement serves aesthetic purposes. However, when the movement is practical, a wide coverage may signal unnecessary occupation.

**Shape**: Shape, as a factor of movement, can be explained in terms of familiarity and unusualness. Movements that follow predictable and commonly encountered trajectories are perceived as familiar. Motion paths that are jagged or non-linear in an unexpected way are perceived as unusual. An expected, familiar shape can elicit feelings of comfort, trust, and approachability for both functional and aesthetic movement contexts. The unusual shape of motion, however, can induce alternate emotions for aesthetic and functional movements. It may signal novelty and playfulness when the motion is aesthetic, and discomfort, confusion, or danger in the context of utilitarian movement.

### 2.3.4. *Utilitarian and Aesthetic Movement*

**Core Element: Movement Elements (Speed, Flow, Space, Shape)** – operational components for design and testing.

Product movement is considered primarily functional. Although examples of aesthetic movements in products can be found, for example, in an hourglass or a mechanical watch, movement is largely perceived as a functional element and not as serving aesthetic purposes. The author conducted an extensive literature review to find out if a classification of movement into aesthetic and functional aspects can be supported from the literature. The author found references in literature to support this classification. For example, when Miyoshi (2018) used the term Kinetic Design in his research, he meant designed objects such as products, furniture, and interiors where physical movement serves either practical or aesthetic purposes. This presents an indication of the possible classification of product movement into two groups: functional and aesthetic movements. Both the aesthetic and functionality of the movement of existing and new products can be improved through Kinetic Design (Ben Hopson, 2009). Although Hopson didn't point towards a classification of product movement, he mentioned how Kinetic Design can potentially affect the aesthetics and functionality of products that have movement in them. This gives an indication of product movement classification into aesthetics and functionality. When drawing the distinction between utilitarian and aesthetic movement components in the context of their effect on emotions, it is worth mentioning that Scherer (2005) talked about the importance of the distinction between utilitarian emotions (facilitating our immediate adaptation to events that have important consequences) and aesthetic emotions (produced by the perceptual and expressive qualities of an object or experience, often tied to sensory modalities such as sound, rhythm, and visual cadence). Based on his classification of emotions, we propose that aesthetic and utilitarian emotions can be associated with aesthetic and utilitarian movements, respectively. The classification of physical movement of products into aesthetic and functional movements is a central part of the proposed framework presented in this paper.

Aesthetic and Utilitarian movements are connected to Norman's processing levels 1 and 2. Aesthetic Movements is one where the user can observe and feel the aesthetics of movement, for example, the movement of disco lights. It contributes to the visual appeal of an object. Emotions generated by the aesthetics are related to the visceral level of processing (D. A. Norman, 2013). The Utilitarian Movement refers to a movement that serves a practical purpose rather than being purely aesthetic or expressive. It is meant to serve a function, for example, the rotation of fan blades or the bread popping out from a toaster. This can be associated with the behavioral level of processing, where the usage of the product or its functionality affects user emotions. The reflective level, however, is responsible for long-term relations. Emotions are strongest at the reflective level. When a designer wants long-

lasting alliances between users and products, they must consider the reflective level of processing, where the user evaluates, compares, and reflects on the value that the product offers.

### 2.3.5. *Product Movement Evaluation Framework*

**Core Element: Aesthetic vs. Utilitarian Movement Typology** – as a foundation for the proposed framework.

Very few researchers have examined the effect of movement in products on human emotions. Therefore, a framework for designers is essential that guides them at the conception stages in the New Product Development process to understand the motion and emotion relationship. In this paper, we propose a multi-level circular taxonomy that classifies four product movement elements (Flow, Speed, Space, and Shape) into a pair of polar attributes (i.e., fast vs slow speed) representing the spectrum of possible motion qualities. These movement traits are then assessed across two types of motion, which are utilitarian and aesthetic. Utilitarian movements support usability and task performance while aesthetic movements enhance user experience through expressive gestures. The same trait, for example, fast speed, can prompt different emotional responses depending on whether it is used functionally or aesthetically. The emotional value of each parameter is further mapped as either positive or negative. For instance, slow may be perceived as calming (positive) in aesthetic motion but inefficient (negative) in functional movement. This structure enables a refined understanding of specific motion characteristics, aiding emotionally informed product design.

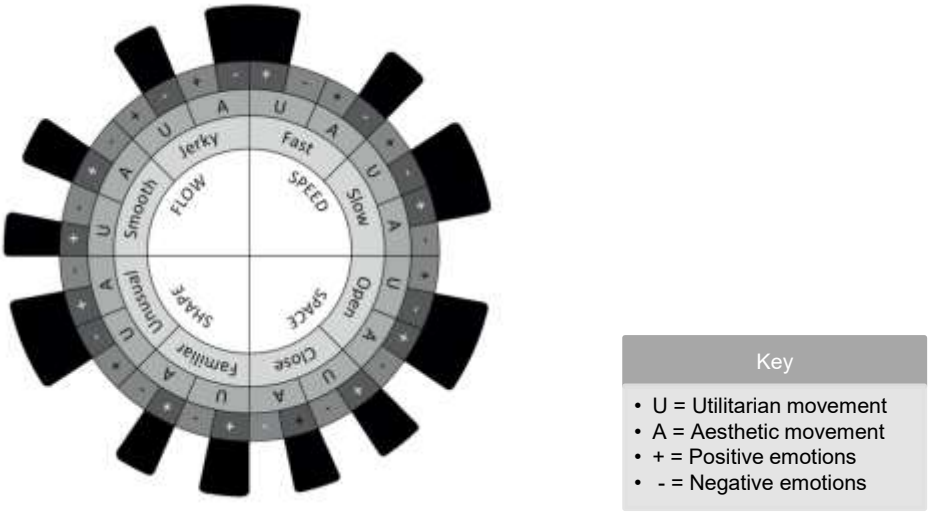


*Figure 8: Product Movement Evaluation Framework*

A user survey was conducted to validate this framework. The emotional responses to motion combinations were evaluated in the survey. Findings confirmed that the emotional perception may be varied based on motion type and element.

### 2.3.6. *Validation Process*

To empirically validate the framework, a structured questionnaire was distributed among general and expert users. Participants were shown short video clips of product movements varying in speed, shape, space, and flow. For each movement, they rated emotional impact on a 7-point Likert scale ranging from very negative to very positive. A total of 56 participants (aged between 18 and 54) completed the questionnaire. The sample included both design professionals (43%) and general consumers (57%). Data was collected over the period of two weeks using an online survey tool. Respondents were instructed to view each motion clip before rating, and all responses were kept anonymous. Mean emotional valence scores were calculated for each motion element under both movement types.

### 2.3.7. *Results*

Quantitative analysis indicated meaningful distinctions in emotional impact based on both the type of movement and the value of each parameter. The elements of speed, space, and shape showed differing emotional effects; however, flow consistently elicited similar responses across aesthetic and functional movements. Flow emerged as a strong predictor of emotional valence. Smooth and continuous flow elicited positive emotions, while jerky or abrupt flow triggered negative emotions. Notably, slower speed was associated with positive emotions in aesthetic movement, but evoked negative emotions in a functional context. Familiar shapes were favorably received in both functional and aesthetic settings; however, unusual or unexpected movements were considered negative in task-oriented settings. Spatial use of movement showed a similar pattern to shape familiarity. Whether expansive or confined, its emotional impact remained consistent for aesthetic application. In the context of the utilitarian movement, an open or expansive use of space elicited negative emotions, but a confined and controlled movement affected users positively.

The findings confirm that product movement characteristics generate context-dependent emotional responses, reinforcing the need for movement-sensitive emotional mapping in product design.

**Core Element: Empirical Validation of Emotion-Movement Correlation** – essential for practical framework adoption.
The following table consolidates core conceptual insights from literature that directly informed the development of the Product Movement Evaluation Framework.

*Table 4: Extracted Core Elements*

| Core Element | Description | Emotional Relevance | Link to Proposed Framework |
|---|---|---|---|
| Kinesthetic Empathy | User's internal simulation or resonance with observed movement (human or non-human) | Drives affective alignment with product motion | Explains how movement elements (e.g., Flow or Speed) evoke emotional mirroring |
| Aesthetic Engagement through Rhythmic or Harmonious Movement | Emotional immersion facilitated by predictable or aesthetically pleasing motion patterns | Enhances emotional attraction and user delight | Supports classification of aesthetic movements and informs Flow/Shape attributes |
| Valence–Arousal Axes | Dimensional emotion model (Russell) positioning emotions along pleasure and arousal axes | Enables mapping of emotional impact of different movement traits | Informs polarity of movement elements (e.g., Fast = high arousal; Slow = low arousal) |
| Non-verbal Movement Cues as Emotional Communicators | Movement as a silent language for expressing intent and emotion | Adds a non-verbal channel to enhance emotional user experience | Highlights role of movement form and behavior in product-human communication |
| Three-Level Emotional Processing (Visceral–Behavioral–Reflective) | Norman's model of how users emotionally respond to product features and behaviors | Enables understanding of short- and long-term emotional responses | Guides how movement elements affect different processing levels |
| Reflective Processing for Lasting Product-User Bonds | Emotional response rooted in identity, meaning, or memory (Norman) | Supports sustained emotional engagement with the product | Justifies need for aesthetic movement that evolves with user reflection |
| Cross-Cultural Emotion Measurement Tools | Tools (like PrEmo, SAM) used to evaluate emotional responses across cultures | Ensures validity and universality of measured responses to product movement | Informs testing phase of framework validation with diverse user groups |
| Kinetic Design as Emotional Strategy | Movement as a deliberate emotional expression in product design | Emphasizes expressive potential of motion beyond utility | Validates inclusion of aesthetic movement as separate from functional |
| Movement Component Analysis (Form–Mechanical–Behavioral) | Dissects motion into physical form, mechanical logic, and expressive behavior | Clarifies how movement conveys functional vs. emotional intent | Grounds typology of movement in layered interpretation of design elements |
| Movement Elements (Speed, Flow, Space, Shape) | Foundational design variables that define motion characteristics | Directly affect emotional interpretation of motion | These four form the core dimensions of your framework |
| Aesthetic vs. Utilitarian Movement Typology | Differentiates between purpose-driven and emotion-driven motion | Crucial to predict emotional valence based on context and intent | Forms the second axis of your framework (movement type classification) |
| Empirical Validation of Emotion–Movement Correlation | Necessity to support theoretical links with measurable user data | Critical for framework adoption in design practice | Justifies use of questionnaires and testing to validate proposed model |

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