

Mind the gap: The 4M Bridge Between 4E-Cognition and Movement-Based Design

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Abstract: Along with technology trends like extended reality, wearables, IoT, and exergames, new design approaches have emerged, focusing on full-body interactions by actively working with the lived body's capacity to sense, feel, and create. Thus, designers are recommended to use movement as part of the design activity when designing for and of movement, regardless of the targeted application domain. However, designing for bodily experiences is challenging. We have identified a gap of no movement-based design framework available, including the moving body as the centre part and core material of the design processes. We recognise the human body is more than a physical object in the world, but a feeling, perceptualising body, that creates meaning in interaction with the environment. It thus frustrates and challenges us to reach a bodily grounded design process embracing the lived body. A common framework informed by the theoretical aspect of embodied cognition and the practical element of movement design can be a starting point for embodied design research. Recognising these challenges, we see a need for creating a bridge between practice and theory. Based on the bridging concept from Dalsgaard and Dindler, this paper presents a movement-based design framework to bridge the abstract idea of embodied cognition theory with the 4E perspectives of embodied, embedded, enactive and extended and concrete movement-based design practices. We created a movement-based design framework structuring the movement-based methods of different perspectives. The 4M model we propose contains three types of facilitator-mediated methods: 1) Mood-setters stimulating a creative body being, 2) Movement-based design methods for creating immersion in creative bodily activities, and 3) Movement concepts as knowledge and evidence for developing and validating movement artefacts. Besides the facilitator cards, the participants have access to Modifiers that can be used in conjunction with the other methods as creative inspiration for exploring, trying, or performing new movement possibilities.

Keywords: Movement-based design, Embodiment, Design methods, Exergames, Design framework

1. Introduction

Our vision is to make movement-based design approaches and practical movement-based design activities accessible to a broader audience of designers and movement professionals who are not movement experts. But even as sports experts in our design practise, we find it challenging to translate an embodied and movement-based design approach into design practice. Recognising this challenge, we see a need for creating a bridge between practice and theory in movement-based design. Based on the bridging concept (Dalsgaard & Dindler, 2014), this concept paper presents a movement-based design framework to bridge the abstract idea of embodied cognition and concrete movement-based design practices.

When designing "for" and "of" movement, designers are recommended to use movement as part of the design activity and build awareness of the fleeting and immediate movement experience (Schleicher et al., 2010; Márquez Segura, 2018; Elbæk & Friis, 2017). With this, we recognise the human body as more than a physical object in the world. It is a feeling and perceptualising body that creates meaning in interaction with objects, the context, and other humans. As Malinin (2019) argues, creativity must be understood as a dynamic relationship between bodily movement, environment, and cognition. Based on the philosophy of embodied cognition, we, along with other scholars, argue for an understanding of how we can unleash creativity in design processes.

In design practice, however, designing sustainable solutions for and of movement poses a challenge for designers regardless of the target domain (such as technology-driven games, sports performance, physical activity, and fun and enjoyment in physical play etc.). As Segura et al. (2016) state, it can be challenging to design immersive bodily experiences due to the lack of spatial and social context in design activities. It, therefore, requires the designer to facilitate the right mindset by designing the optimal process through choosing and

interconnecting methods to explore embodied movement as a medium of creativity. Therefore, the successful application of movement-based design relies primarily on the individual designer's knowledge and practical movement skills (Svanæs & Barkhus 2020). It requires effort from the designer in planning, facilitating and analysing movement insights. Therefore, the designer must possess both confidence and skills to facilitate and engage in movement-based design (Andersen et al., 2020).

We believe that there is a gap of no movement-based design frameworks available to advance theory-grounded movement-based design practice and with movement as the cranksaft of the design process. In the domain of exertion game design, Müller et al., 2011 have created an exertion game design framework with the moving and active body as one of four elements. However, we believe there is a need for a movement-based design framework with the moving body as the approach's core.

Thus, we want to democratise movement design and unleash movement creativity for engineers, designers, and students and enhance sports and movement professionals' awareness of their core design competencies. The 4M-framework we present bridges abstract theory and design practice through a holistic view of movement-based design, which can be applied across contexts and target domains. We believe in our mission through this embodied design approach to support the creation of more sustainable and engaging movement-based design solutions.

2. Applying a “bridging concept” between embodied philosophy and movement methods

Practical design research happens in the research themes and activities between philosophical, theoretical, methodological, design activity (methods), and the making of designed solutions (Koskinen et al., 2011). A bridging concept bridges the themes and activities, and is a mean for limiting thoughts, supporting a discussion, and planning supported by the intermediate knowledge one has.

Created by Dalsgaard and Dindler (2014), the bridging concept forms an intermediary link in its ability to bridge the gap between an abstract overarching theory and concrete practice. A bridging concept consists of three defining constituents: a theoretical foundation, a set of design articulations, and a range of exemplars that demonstrate the scope and potential of their application. Following Stappers & Vissers (2014) terminology we create a bridge between the abstract level of the philosopher and the concrete level of the designer via our framework.

The framework supports future facilitators and designers who wish to understand the means and mechanisms of creating an immersive process for movement-based designs. Even though it is an inherently unstable and intermediate form of knowledge (Dalsgaard & Dindler, 2014), the framework is meant to support the design process and not hinder it.

3. Approaching Movement Creativity through Radical Embodied Cognitive Science

Designing creatively for and of movement is highly immersed in the personal being of the designer and interwoven into the external world. Thus, applying a philosophical concept that uses a holistic understanding of cognition is preferable. Radical Embodied Cognitive Science (RECS) frames cognition to embrace the brain, body, and the world in a dynamic system (Malinin, 2019). It goes beyond seeing the brain/mind as a computer located in the head disconnected from the environment and sees cognition as a constitution united between mind, body, and the world. A way to understand RECS is by the 4E concept, which involves the body and the body's situatedness in the environment (Newen, Bruin & Gallagher 2018). Each concept within 4E is each intertwined with one another, making the cognition process complex and always embodied, embedded, enactive, and extended.

Embodied cognition refers to the premise that perception and cognition are embodied and impact whole-body interactions with the world. Mental phenomena such as perception, memory, reasoning, language, emotion, and consciousness are constituted and depend on the entire body.

In the concept of RECS, embedded cognition is understood as rooted within a specific context and oriented toward action (Newen, Bruin & Gallagher 2018). Thinking in action is related to how the environment allows focusing on the relationship between our improvisational or adaptive actions and the situation.

Enactive cognition relies on motor activities (action) and sensory perception, and there is no significant difference between acting and perceiving. Enactive cognition is interactive with the biological and nonbiological environment and requires a continual negotiation between the individual and the collective community.

In extended cognition, thinking is understood beyond the body and the mind. Here, physical things in our environments are seen as part of the cognitive system, and we must understand our beings-in-the-world as a connection and a constitution between our body and the world.

Putting this understanding of cognition as a complex process involving the 4E's, "embodied creativity includes creative expressions and processes that emphasize or are generated by the physical body. This view of creativity highlights physical responses within creative practice and is attentive to the influences of space, environment, materials, and the individual's relationships to other bodies" (Griffith, 2021). We view this understanding of cognition as stressing that the state of being in the world should be considered when designing for, with, and of movement in sport, movement, and play. We must consider how to practice design for movement in a social and cultural world, where our bodily engagement with the environment is part of cognition and creativity.

4. The genesis of the 4M framework

We used constructive design research methodology (CDR) (Koskinen et al., 2011) as an overarching approach to structure in designing the framework. In CDR, the creation of a design is founded on both abstract theory and practical and research-based knowledge, and the creation of physical or social artefacts is the key to knowledge production. In our process, we constructed and re-constructed a provisional framework, aiming at encapsulating our understanding of the overall movement-based design process. Our design process was advanced by several workshops, building prototypes of methods cards, building prototypes of the framework, testing movement-based practices, conducting desktop research, and discussing theoretical and practical aspects. We summarise this process three years process in two distinctive phases we call Storming and Symphony. The storming phase consists of an explorative approach for iteratively creating movement-based methods cards and the framework. In the symphony phase, we tested movement methods and the framework and consequences of our decisions.

5. Presentation of the 4M framework

Based on the design process, we have developed the 4M framework as a model for understanding approaches when designing for, of, and with movement in sport, technology, game, and play. The 4M framework consists of four elements of movement-based design activities: Movement modifiers, Mood setters, Movement methods, and Movement concepts (figure 1). The 4M model illustrates a box placed on top of Modifiers that you can use along with the three other types of movement methods. The box' red foundation (bottom) is the Mood-setting. The green movement methods on the left side of the box embrace design methods with a Movement-first approach. The right blue side of the box represents Movement-concepts of knowledge.

The framework is inspired by Karoff (2013) understanding of play as a triad interplay between play media (nouns), play practices (verbs) and play moods (bodily state of being). The framework takes a constitutional stand in movement-based design (Andersen et al, 2020) acknowledging the movement-first approach (Segura 2016) and movement as a medium for different aspects of design activities (Loke & Robertson, 2013), adding specific movement and sport theory and evidence. The framework enhances an understanding of how to create and enrich a movement-based creative design environment. In developing a movement-based design framework we strive for making movement-based methods navigable and actionable in the fields of interaction design, game and learning design as well as in sport & physical activity design. With 4M, we strive for having a medium to gain confidence in using movement in design practice. The target users of the framework are students and design professionals across disciplines such as engineering, design and PE, sports, and movement-health.

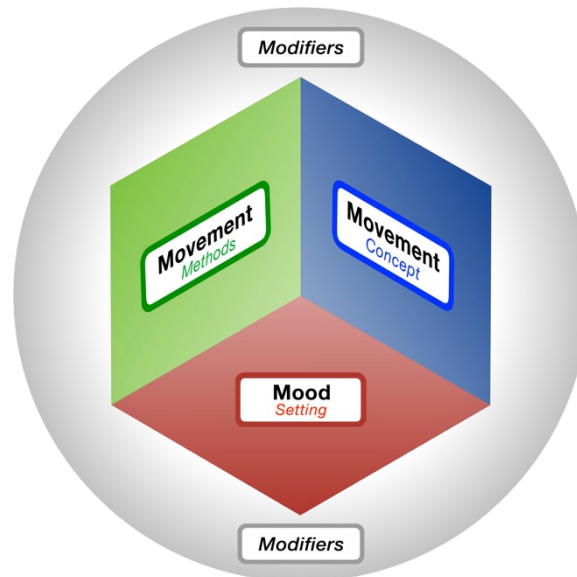


Figure 1: the 4M framework for movement-based design

The four constituents are independent of each other. Consequently, any chosen movement method does not rely on a corresponding mood (setting) or a relevant movement concept. By adding the different constituents, we suggest that a movement-based design practice has different layers and perspectives, and that designers or facilitators must understand and plan design processes recognising these layers and perspectives.

In the next section, we provide a description and examples of the four constituents to give an image of the separate elements and how they guide the movement-based process.

5.1.1 Mood setters

Having movement at the centre of interaction design and as the medium of design, it is our experience that being in the ‘right’ state of body being is essential for choosing a movement first approach in the design activities and thus practising warm-up like activities. The Oxford Dictionary of Sports Science & Medicine defines a warm-up as typically comprising “mild exercise to raise tissue temperature and stretching” and “to prepare the athlete psychologically”.

We propose and classify a variety of warm-up games as Mood Setting. The activities prepare participants physically, socially, mentally, and for movement design purposes, also include embodied creativity training. It embraces activities such as icebreakers, warm-up exercises, team building, and physical technology-supported games (Márquez Segura et al., 2021). We use a typology for making the Mood-setting method identifiable regarding function in the design processes. The typology contains Exertion, Playfulness, Body Awareness, and Creativity. Altogether, the Mood Setting activities are warm-up like energisers with a creative potential. For the participants they typically take place before the primary design activities and can be applied to energise the design process. Further the movement methods will be searchable by the duration of set-up time and proposed activity time, proposed number of people participating (social configuration), and material (props) needed.

5.1.2 Movement Methods

Design methods are generally known as a designedly way of working in a design process. Well-known design methods are brainstorming and sketching with the general idea of using primarily cognitive processes. The framework constituent of Movement methods contains design methods, which use movement as a medium to explore, stimulate and activate designers and their creativity in a design process (Andersen et al., 2020). The use of movement as a part of the design process stems from practices such as dance, sport, rehabilitation, and theatre (Höök et al., 2017). It has sparked the emergence of embodied sketching (Segura et al., 2016) and movement-based interaction design disciplines (Loke & Robertson, 2013). We acknowledged the body and movement as a way for designers to engage in design challenges to pursue insights (Andersen et al., 2020).

The Movement-based methods have a specific context-bound design goal. Dividing the methods through how they use movement as a medium to achieve the design goal, we informed by Andersen et al. (2020), further

develop the categorisation of the methods into Exertion, Playfulness, Body Awareness, and Role-Playing. Further the movement methods will be searchable by the duration of set-up time and proposed activity time, proposed number of people participating (social configuration), and material (props) needed.

5.1.3 Movement concepts

Informing the design, we propose using multi- and cross-disciplinary research-based evidence and theory as a knowledge foundation when designing for and of movement, sports, and interaction technology. Peters, Loke and Ahmadpour (2020, p. 417) define a concept (cards) as “Some tools present chunks of expert knowledge in a manageable manipulable form”. Based on different disciplines in scientific areas, we have developed Movement Concepts in the areas of Philosophy of Sports and Movement, Psychology of Humans, Humans in Society, Motor Learning and Biomechanics, Physical Training and Physiology, Sports, Games and Play, and Sports and Movement Technologies. The Movement Concepts includes manageable descriptions of theories, knowledge, and evidence, plus generative questions, and reflective questions to support informative decisions making in the design process.

5.1.4 Movement Modifiers

Movement modifiers include cards and physical artefacts that support, modify, tweak, or disrupt design practices. Informed by Peters, Loke and Ahmadpours’ (2020) review, method cards formed as props, fuel divergent thinking as a scaffolding of the design process. The artefacts stimulate physical exploration and creativity when participants use them in design and real-life settings. Engaging and moving with the artefact can be generative for the design activities. Modifiers can also be words or pictures related to a sport, movement, or sports theme, and they are placeholders representing components within a system. Modifiers can tweak movement like, e.g., via cards of movement qualities, types of core movements, movement metaphors, different sports disciplines, play and play elements. Movement can be modified using technologies and game genres and types. Modifying people using personas and constraints. Modifying motives through experiencing movement through different lenses & logics, stances & values, and perspectives of movements.

6. Bridging the framework to practice

We will exemplify the framework from two perspectives: 1) “design *of* movement” in the Creative Acrobatic Body course for sports science students and 2) “design *for* movement” with the HangXRT bodystorming case. For the 4M model in use, we first describe the case then, the concept of the 4M model is related to practice use.

6.1 Case presentation: The Creative Acrobatic Body

The Creative Acrobatic Body is a 3 ECTS bachelor course for Sport Science Students at our local university's innovation track. The students' course task is to create a bodily acrobatic performance informed by or invented from movement cultures of their own choice, e.g., parkour, new circus, creative gymnastics etc. The student's assignment is to produce an informative inspiration video showing parts of the performance and core elements of the process of creating said performance. The course provides students with the knowledge and practical experiences in different acrobatic movement practises. We introduce how embodied creative and playful learning processes unfold within innovation. The course is structured as 1) formalised lectures and 2) practical workshops. Before any practical workshops, the students participate in a lecture-based on the coming practical workshop (e.g., the culture of parkour, gymnastics, parkour, or new circus).

Applying the 4M framework in the workshops, we recognise icebreakers, warm-up, and team-building activities to enhance the participants' mood-setting towards playfulness, trust, and creativity. A Mood-setting activity used was “Follow the leader”. In the workshop, we introduced and practised movement creativity based on the structure of the 4M framework by;

1. using Modifiers, physical prompts (artefacts), movement qualities images, and play formats on word-cards as embodied creativity disrupters
2. improvising movement as a Movement method to explore acrobatic movement possibilities
3. using the context and theme knowledge from the formal lectures to reach the design goal as a representation of Movement concepts
4. using music to facilitate creativity and, as such, representing a Modifier (Segura et al., 2016).

The last workshop element was video documentation of a mini-performance for further feedback and reflection on the process of working with embodied creativity.

In their self-guided work, the student applied movement methods such as props and gym equipment experimentation as an emergent movement method represented in the 4M framework.

The workshops and the students' self-guided project work illustrate how both facilitators and students apply the 4M framework and the movement methods, respectively, in their teaching and learning. It includes designing and practising their performance and sharing visual (video) knowledge to inform other potential users' embodied creativity and "design of movement".

Our next case shows the 4M framework's potential focus on designing for movement.

6.2 HangXRT bodystorming through the 4M framework

Segura, Vidal and Rostami (2016) created the workshop HangXRT to design computing technology games that encourage vigorous physical activity and physical fatigue. The workshop's background lies in the knowledge of how physical fatigue resembles what happens with real-world sports, and such a game provides physical and cognitive advantages.

Segura, Vidal and Rostami (2016) succeed in allowing participants to engage in embodied ways of designing supported by an atmosphere of physical and social play. The general idea of the workshop was to utilise the principle of show, don't tell and let the environment become a design resource. The generative workshop approach involved an on-the-spot complex design space of people, technologies, artefacts, and physical elements in a bodystorming session to envision and act through physical activities. The core artefact was the TRX suspension trainer, a piece of equipment attached to the ceiling. Participants hung and moved with, within and around the TRX. Other playful artefacts were provided as inspiration for the participants, and the facilitator instructed them to take turns in their experimental actions with the TRX and the artefacts.

Understanding HangXRT through the 4M framework, we see Segura, Vidal and Rostami (2016) utilise movement methods by placing the TRX at the centre of the room and making the participant experiment with movement through the TRX and the principle of show don't tell.

The participants were encouraged to involve other artefacts to change the perception of the movement and the concept. The group is observed bringing in balls, skateboards, and mats for tweaking the bodystorming process (Segura, Vidal & Rostami, 2016). In doing so, aiming toward physical exploration instead of classic cognitive problem-solving and the artefacts are seen as modifiers supporting this physical exploration. While at the same time recognising the mood-setting part of the 4M framework by addressing the artefacts as playful artefacts.

The Movement-concepts of the 4M framework stem from the participants involved in the process. The participants were experts in physical activity, exertion games and motivation; the theory was the foundation of the design (Segura, Vidal and Rostami, 2016).

The design of the technological solutions for TRX starts with a movement first approach. We show the potential of using the 4M framework to analyse design activities and structure future developmental processes alike.

6.3 Designing with movement – implication, reflections, and recommendations

We for now proceed with our reflections on the bridging of the 4M framework with the 4E theory and we will discuss implications, reflections, and recommendations.

Alongside the sports and movement focused technology trends new design approaches have emerged, focusing on full-body interactions by actively working with the lived body's capacity to sense, feel, and create. We have to a lesser extent been able to bridge an embodied understanding of cognition and movement-based design approach into practical design activities. We created the 4M framework to bridge the theory of 4E and with this enhance the practical use of 4E creativity (Malinin, 2019). As Malinin (2019) states, based on the 4E, "creativity does not begin with an idea in the head that is subsequently realized; it emerges through interactions with others and artefacts of the material environment". The 4M framework makes a bridge for non-movement experts and experts to understand and structure movement focused design processes that take into consideration the elements of 4E – embodied, embedded, enactive and extended cognition in both divergent processes and convergent processes of a design process. As 4E operates with an extended form of cognition involving bodily,

material/technological, socio-cultural, and temporal dimensions (Malinen, 2019) the 4M has a Mood setting to promote a forthcoming social-cultural environment.

The embodied dimension of 4E points to the embodied being and thus the mood of your body being will affect the creative potential. As the phenomena of perception, memory, reasoning, language emotion and consciousness are constituted and depend on the entire body. The Mood-setters as warm-up games are drawing on these cognitive phenomena from a movement-based and playful approach striving for loosening up for internal creative potential as well as reaching out for and connecting to fellow participants taking part in the design activities. The Mood-setting activities have affective, social, trust formation, perceptual, cognitive, and physiological outcomes. As such warm-ups as embodied games show potential toward unlock innovation, creativity, and intelligence (Segura et al., 2021). The Mood-setting we interpret as having an embodied metaphorical creativity training dimension. Thus, drawing on how movement may enact embodied metaphors. It also draws on that walking and particularly free walking improves divergent thinking (Malinen, 2019).

The Movement methods involve bodily actions, and the modifiers give access to a wide variety of material and technological artefacts. Thus, for Segura (2016), the embodied ideation is realized in the participants' lived physical and social life world. The holistic approach that Segura is describing in most aspects builds on the potential use of 4M and primarily on perception-in-action as defined for the enactive perspective of the 4E model and makes a movement first approach by Segura (2016) actionable. The 4M framework we believe used in an open and situational adaptive way will be part of forming design as creativity-in-the-wild (Malinin, 2019).

In developing the framework, our focus was on design for movement and design of movement as described in the two cases. Although we recognise the framework is more than of and for movement in design with movement. We are convinced the framework can also be used in numerous design settings, e.g., bus stops, supermarkets etc.

Conceptualising movement as a medium that stimulates, forms or catalyses insights within the design process, we reject a focus on how much movement. Instead, we advocate for how movement promotes energy and catalyses insights, we argue for design activities not directly related to design for and of movement. For this, the 4M framework could be relevant for designers and non-experts of movement to use movement-based and embodied design approaches.

7. Concluding remarks

Authentic movement-based design requires sympathy with the movement, and the context, establishing a forthcoming interaction between the participants, fostering a creative body being and thus enhancing positive, creative moods among the participants in the co-design processes. The 4M framework is based on the prerequisite that the environment is an umbrella term to describe both human-specific environment (habitat) and actor-specific environment, the outside world. It is evident that bodies, artefacts, and environments shape creative processes (Malinin, 2019). First, it involves an experimental examination of embodied metaphors associated with creative thinking reified through mood-setting in the 4M framework. Second, it involves a systemic approach that implicates the whole creative process of problem finding and forming, generating, testing, and elaborating on ideas to develop a product or service (Malinin, 2019). This approach in the 4M framework is reified in the Movement-methods and through Movement-concepts. Thus, Modifiers are available for tweaking both the Mood-setting and the Movement-methods and the Movement-concepts.

We recognise that testing and evaluation of the 4M framework and its grounding in the 4E radical embodied cognitive science still will have to be established to document the actual value of the framework.

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