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MAPPING MOVEMENT
A HUMAN MOVEMENT-BASED FRAMEWORK FOR THE CREATION OF ORGANISED INTEGRATED EXPERIENCES

Natalie Ebenreuter, PhD
Alcatel-Lucent Bell Labs France
natalie.ebenreuter@alcatel-lucent.com

ABSTRACT

In this paper a framework for mapping human movement that matches the logic of describing corporal action with an organised integrated system of interaction is offered. To achieve this movement constructs that draw on broad terms of movement descriptions required by the language of Labanotation to create movement are used in combination with a noun-verb interaction model to communicate human actions that share a direct relationship to interactive system objects and operations.

Underpinned by the development of an idea, as an organising principle, the framework supplies designers with a starting point to create interactions that align corporal motion with emerging uses of technology and product qualities. This allows for the interplay between different forms of interaction that unite movement with objects, actions and product qualities to be documented. The framework is described and illustrated by way of example and is extended to include mobile devices in its formation.

Keywords: Movement-based interaction, movement constructs, Labanotation.

INTRODUCTION

A variety of technological advances make it possible to manage software system operations through gestures and human movement. Computer vision with the aid of cameras, sensor technologies and other technical innovations have made tangible user interfaces, body-based and haptic interaction a reality. In doing so, these technologies have drastically transformed the well-known forms of interactions we have learnt to produce with the aid of a mouse, keyboard or stylus.

New ways of facilitating communication between a system and end-user through the recognition of human movement and its association to appropriate system responses is a challenge that the field of interaction design is seeking to address. Added to this is the ability to leverage a foundation or language, in which movement-based interactions can be discussed, documented and effectively communicated between designers, engineers and project stakeholders.

The study of movement in a number of design approaches have leveraged the foundation of Rudolf Laban's movement notation system, called Labanotation and the theory of Laban Movement Analysis (LMA) to interpret, analyse, document and enhance the emotional expression of human movement (Camurri, Mazzarino, & Volpe, 2004; Costa, Zhao, Badler, & Chi, 2000; Jensen, Buur, & Djajadiningrat, 2005; Klooster & Overbeeke, 2005; Rodríguez Ramírez, 2006). Drawing on Laban's theory of effort Camurri et al. (2004) illustrate how expressive cues in human movement can be used to develop new paradigms that seek to enhance the experience of human computer communication. Young et al. (2005) explore the concept of 'a language of movement' and look at ways to build links between movement qualities and product functions to enrich the behaviors of industrial design products. Labanotation has also been used as a tool to assist researchers in identifying aspects of functional and performed movement for the design of movement-based interaction with technology (Loke, Larssen, & Robertson, 2005). Alternatively, Jensen's (2007) research highlights the use of

Laban's effort and shape concepts to create a common vocabulary in which design students can communicate and develop interactive movement qualities.

While, there exist a number of interaction design approaches that draw on the principles and theory of movement notation systems, Saffer (2008) claims that they do not account for the relationship between humans and an interactive system. He argues that the use of notation systems in design and in particular for documenting interfaces is more suited to highly complex systems of gestural interaction. While Saffer's view illustrates one perspective, the language in which notation systems illustrate movement provides a basis where new ideas and interactions between people and objects can be developed objectively from a most simple to complex level (Hutchinson Guest, 1984). Furthermore, Loke et al. (2007 p. 699) tell us that the notation system 'Labanotation can easily be extended to describe a person's relation to virtual or computerised events, objects and environment'.

For Gropius (1955), the ability to move freely within the bounds of a grammar or language that he envisioned for design was essential to the creative expression of ideas and form. In particular, he (Gropius, 1955) stressed the importance of an objective scientific knowledge of the theoretical underpinnings of the art, which he refers to as a 'language of vision'. The notion of a visual language concerns the nature of abstraction and objectivity in which schemata or plans enable designers to literally examine a diverse array of ideas. Visual representations of information or data far removed from their contextual surroundings enable designers to gain insight into the intricate relationship between the parts of a design situation and its whole. However, this is not necessarily an isolated view. Schematics and plans facilitate the collaborative understanding and development of ideas, and assist us to look objectively at the actions and decisions we make (Novak & Gowin, 1984). One context for their use is for developing and analysing specific sets of tasks and actions that allow diverse groups of individuals to reach a common goal.

The focus of this research concerns the manner in which various elements of the language of Labanotation can assist the creation of organised integrated experiences between humans and interactive systems. It contributes to the tools available to designers of interactive experiences by providing a framework that illustrates the relationship between system objects and actions in relation to different elements of human movement and product qualities. In the following sections I give context to this research. I begin by discussing the role of movement notations systems and highlight the strengths and weakness of Labanotation in application to design related research. To overcome the issues involved in the practical application of Laban's movement concepts to the design of interactive products, I propose a method of modelling system objects and actions that corresponds the logic of describing and performing movement with a system of interaction. In doing so, the manner in which movement is described becomes a way to design interactive experiences that complement system objects and actions. Research results surrounding the method of modeling movement in application to the design of an interactive tool, are also discussed.

As a final point, I draw on Laban's theory of effort to enhance the proposed framework. This is done to offer designers the potential to create product qualities that align with human and system interactions. By way of example I illustrate the overall application of the framework to the design of gestures for free-form interactive gestures. Accordingly, I conclude with further remarks concerning future directions of this research.

MOVEMENT NOTATION SYSTEMS

In general movement notation systems permit varying degrees of detail to be captured in the documentation of movement. To achieve this vital aspects of motion are recognised by notators, individuals trained to use notation systems, and are recorded in a variety of symbolic languages. The signs and symbols that constitute notation systems are comparable to the use of music notation for musicians and the written word for drama. The process of documenting different movement aspects relies upon elements of the body, location, direction, weight transference, style, duration, and dynamics to be recorded accurately (Hutchinson Guest, 1984). A comparison can also be drawn between the technique notators use to identify and record key elements of action, and the key poses of action traditional animators record as key-frames to generate animated movement.

A broad range of notation systems have been developed for the analysis or description of movement in a number of disciplines such as personal assessment, interpersonal communication, dance, clinical medicine, animation, anthropology, physiotherapy, psychotherapy, athletics, and industrial time and motion studies. More recently, they have found application in the field of interaction design and in particular the language of Labanotation to movement-centered interaction.

Created by Rudolf Laban in 1928, Labanotation is documented on a vertical staff, and is read from bottom to top. A Labanotation score presents a description of movement from the rear view of a performer (See Figure 1). A Labanotation staff is made up of three lines that are divided by a centre line to indicate the left and right side of the body. This provides a symmetrical representation of the body in which each column of the staff is reserved for a specific body part (Hutchinson Guest, 1984). Information pertaining to time, direction, level, and body part is contained within a single Labanotation symbol. This is illustrated by the particular shape, shading, and size of each symbol. Labanotation represents the duration of movement through the length of its symbols that is proportional to the time it takes to perform. The design of a system that embodies elements of time in this manner eliminates the need for a visual reference to a musical score alongside the movement notation.

To underpin the usefulness of Labanotation in design Loke et al. (2005 p. 113) tell us it ‘supports a representation of movement that can be easily linked into the context and point of interaction, which provides a valuable foundation for the design of movement-based interaction’. In support of this, Young et al. (2005 p. 8) believe ‘the most useful information gained was in the way that Laban explained movement in terms of a make up of qualities. E.g.: direct and indirect movement, short or sustained, towards or away’, whereas Labanotation offered Jensen (2007 p. 242) ‘a heightened sensitivity towards movement and natural language terms’ in his research activities.

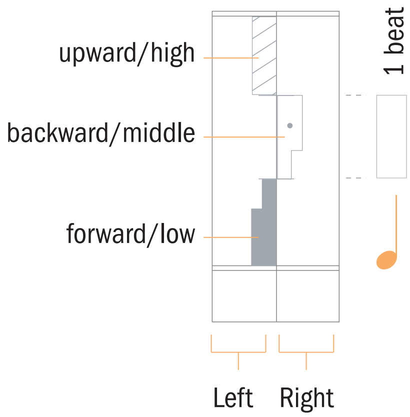


Figure 1. Labanotation rimer

However, Labanotation poses distinct challenges in the learning of its extensive range of symbols, when compared to other systems (Yasuda, 2001). This is because of the broad vocabulary and number of symbols that Labanotation uses to define motion. Hutchinson Guest (1977) tells us that information portrayed by notation symbols that allow for the research and analysis of movement require abstraction. This means that abstract notation systems, such as Labanotation, are criticised for their ability to perform as a visual language in the immediate documentation and interpretation of movement. These issues have also been identified in application to the field of design (Höysniemi & Hämäläinen, 2004; Loke et al., 2005). In particular Young et al. (2005) found Labanotation quite challenging to use in the design of expressive products. They (Young et al., 2005 p. 8) argue that it ‘is very laborious and would never be employed in a design process due to the fact that in design we (designers) don’t work with just one form’. Subsequently, they found its central focus on human forms of movement to be too restricting to apply to other interactive forms. This is a challenge, nonetheless, that this research seeks to address.

Despite the complexity of the language, one of the advantages of Labanotation is that it is not limited to the analysis and description of corporal movement alone. Labanotation has the capacity to keep a record of the relationship of human movement with respect to music, parts of a room, objects such as props and other people that move in isolation and in partnership with the key description of human movement over time (Hutchinson Guest, 2005). I argue that the potential to utilise the language of Labanotation that takes into account the dynamic relationships between 1) individuals, 2) external objects such as electronic devices and interactive systems, 3) their spatial relations, and, 4) expressive qualities, provides a powerful basis for the design of rich user experiences.

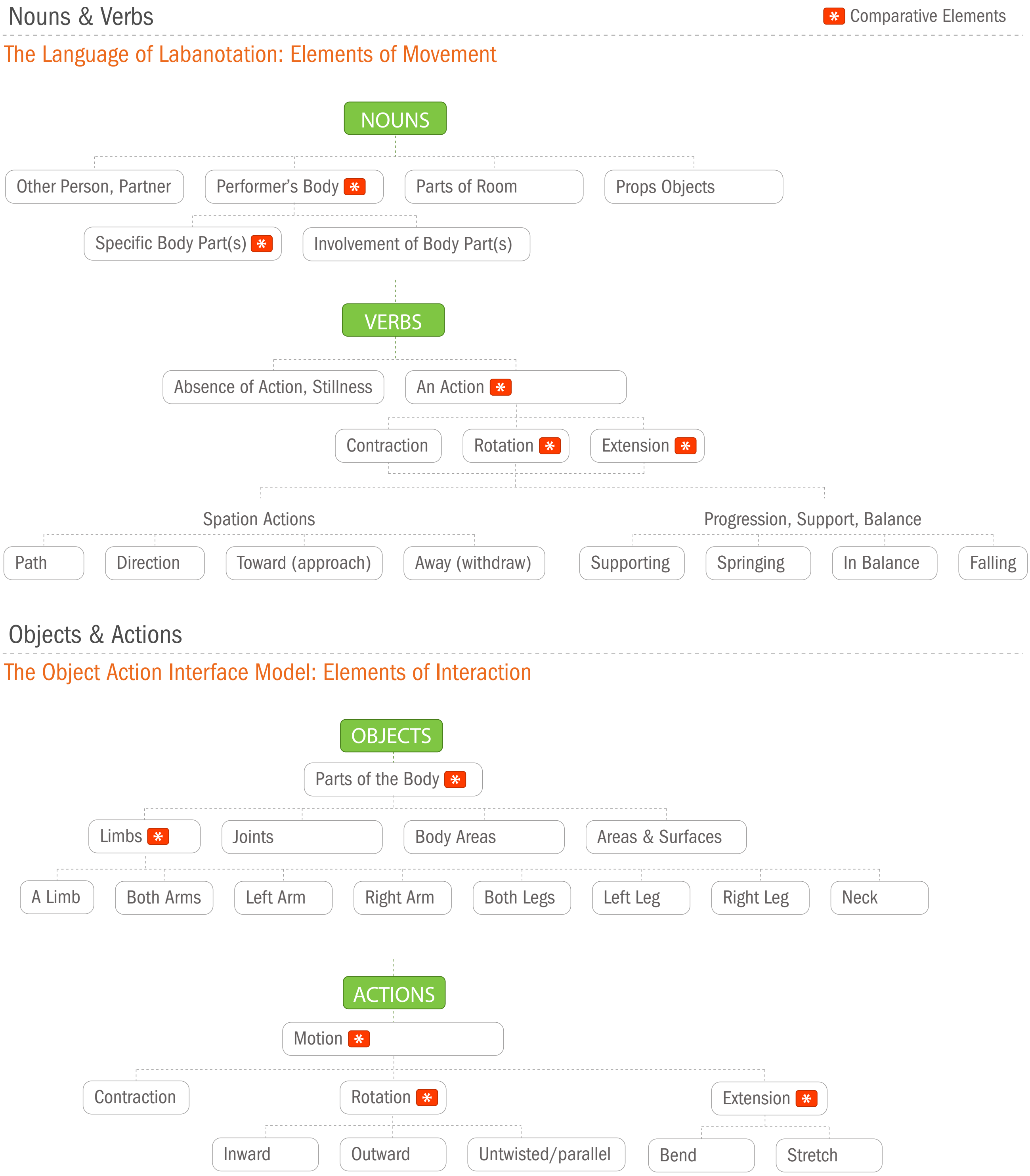
MAPPING MOVEMENT

The language of Labanotation follows a grammatical structure that is used to posit actual movement with appropriate words. Hutchinson Guest (1977 p. 19) illustrates the correspondence of movement to a linguistic form in a 'Movement Family Tree'. As with most written and verbal grammars, Labanotation can be broken down and classified as nouns, verbs, and adverbs. A noun can refer to individual body parts that move; a verb to the action or positioning of a body part; and an adverb to indicate the duration and style of its performance (Hutchinson Guest, 2005). These elements are then used to create descriptions of movement just as sentences are formed in natural languages like the English language. While this approach illustrates a linguistic analysis of Labanotation, elements of the language can be distinguished with regard to the motivational and analytical concepts that underpin its use. Hutchinson Guest (2005 pp. 12–13) identifies these in relation to their directional destination, motion, anatomical change, visual design, relationship, weight, balance, dynamics, and rhythmic pattern; which have a direct impact on the form of movement descriptions and method of analysis. The significance of these movement characteristics lies in the potential to develop a foundation for the description of movement that utilises the conceptual, verbal, structural, and motivational or actionable elements of Labanotation to communicate a dialogue between an interactive system and end-user.

A method of description comparable to the grammatical structure of words and sentences allows for a sufficient level of expression with regard to the characteristics of movement description. It allows for an association between the object of movement and its action to form a logical relationship with each other, and in the context of a complete sequence of movements (Hutchinson Guest, 1977; 1984). This is significant to the design of movement-centered interaction because it offers designers distinct parameters in which human movements can be structured to align with various actions and objects in digital environments.

As a foundation for information architecture, an object-oriented, noun-verb interaction model provides designers with a framework that can be used to develop new methods of interaction, in application, to target specific user tasks and goals (Shneiderman & Plaisant, 2005; Tidwell, 2011). When the grammar and syntax of movement specification offered by Labanotation is adapted for use with a noun-verb interaction model, it provides an effective framework for the design of interactive task structures. Figure 2 illustrates this association.

The mapping in Figure 2 was produced during the creation of a prototype application called, LabanAssist (Author, 2008). The prototype application was co-created with and for students and educators of Laban's movement notation system at the Ohio State University. Taking a participatory design approach to the creation of LabanAssist (Author, 2007), the prototype application was designed to assist members of the dance community to document movement creatively. The language of Labanotation in combination with a noun-verb interaction model provided a foundation for the development of system of interactions that enabled dance students to effectively describe and choreograph movement.



Reference: Hutchinson Guest, Ann. Labanotation: The System of Analyzing and Recording Movement. 4th ed. New York: Routledge, 2005. p16

Figure 2. Mapping movement and interactivity for the interface.

MOVEMENT CONSTRUCTS

The structure and mapping of movement to a system of interaction is facilitated by the composition of movement constructs. I use the term movement constructs to refer to the broad terms in which movement-based interaction can be composed and described, based on the grammatical structure of Labanotation. This is achieved through an interactive process of identification, association, selection and modification. The discovery of the range of possibilities offered by the representation of broad terms (See Table 1) used to describe the elements of

Movement Constructs	Possibilities (non exhaustive)
Nouns	
Involvement of body part(s):	Foot, footstep, knee, hip, hand, head, torso, limb, arm, leg, ankle, neck, face, shoulder, elbow, wrist, finger, thumb, toe, all/full body
Performer's body part(s):	Foot, footstep, knee, hip, hand, head, torso, limb, arm, leg, ankle, neck, face, shoulder, elbow, wrist, finger, thumb, toe
Body areas	Chest, waist, pelvis, shoulder section, whole torso, upper front of chest
Areas & surfaces:	Palm of hand, sole of foot
Location:	Facing, space, in front, behind
Parts of the room:	Front, back, right, left, forward right, forward left, back right, back left of the room
Other person, partner:	Number of people /partners
Props, objects:	Different item(s)
Verbs	
Stillness:	Pause, hold
Action:	An action, the absence of action
Duration:	Amount of time
Direction:	Forward, left side, right side, left forward diagonal, right forward diagonal, left backward diagonal, right backward diagonal, backward, place
Level:	Low, middle, high
Spatial actions:	Toward, away, path
Rotation/twist:	Inward, outward, untwisted/parallel, degree
Extension:	Bend, stretch, degree
Contraction:	Degree
Untwisted/parallel:	Degree
Supports:	Supporting, springing, in balance, falling
Turns:	Left, right & degree
Jumps:	Jump, leap, hop

Table 1. Basic movement constructs

movement; their interactions and physical placement underpin their conceptual formation. It is important to understand that movement constructs used to facilitate the design and descriptions of human movement are not prescriptive in any way.

Furthermore, the assignment of movement constructs to task objects and actions are not considered as fixed categories. This is despite an implied association because of their assignment to a particular arrangement or ordering as illustrated in Table 1. Movement constructs are conceptual tools that can be used to explore they many ways in which movement-based interaction can be conceived.

Dewey (1910) tells us that orderly interaction may follow if an object or item is recognised and considered in relation to a key subject or theme. This is made possible when the identification and association between the broad terms that movement constructs offer to support the design of interaction are consistent with the overall theme and possibilities they suggest. The organisation of thought can therefore be as a result of organised action or a number of interrelated interactions surrounding a particular subject or idea (Dewey, 1910). This is where the significance of the conceptual, verbal, structural, and actionable elements of Labanotation comes into play; when an idea and its active formulation, regardless of its foundation, becomes the organising principle behind the realisation of what is expressed (Burke, 1969). Here, an idea is understood as the organising principle behind the choice and development of interactions that are required to describe and design movement-based interactions. Similar to this understanding while not the same, Jensen (2007; 2005) found that using Laban's effort and shape qualities to describe and characterise movement qualities enabled designers to employ the use of metaphors as a way to represent ideas as objects, which in turn gave shape to the future actions of designers' productive outcomes.

Product usability tests of the prototype application LabanAssist suggest that through the effective mapping of interaction to the design of an interface, its utility and functionality in assisting the composition of movement was successfully communicated. With specific application to this research, the use of movement constructs enabled end-users of LabanAssist to build relationships between the selections of broad descriptive terms in an interface (see Figure 3), and then compose diverse descriptions of movement. In this way, thought and language become a motive for action that transforms the verbal vocabulary of Labanotation to a description of movement. The significance of this lies in the accessibility of movement constructs to describe corporal action in broad terms that align with the theory and vocabulary of Labanotation. In this way a symbolic understanding of the language of Labanotation is not required to follow a movement-centered approach in the design of movement-based interactions for emerging technologies.

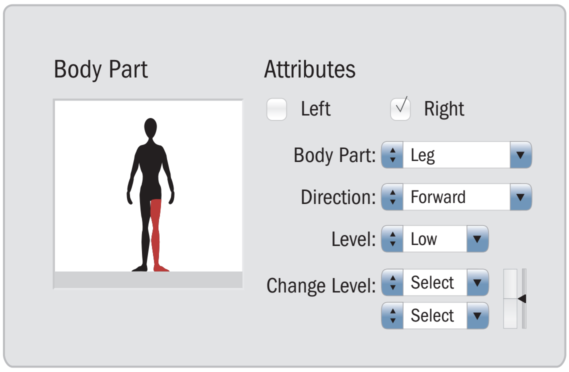


Figure 3. The application of movement constructs

Further research findings from the LabanAssist product evaluation, using a five-point likert scale, tell us that students strongly agreed that the structure of the system's operations guided them through the process of describing movement and that it was easy to learn how the logic of the system operated. Therefore, a structure of interaction that is relatively straightforward is made possible when corresponding movement constructs that assist an integrated description of movement elements are assigned to recognisable task objects and actions. An example of this is illustrated in Figure 3; where the terms body part, direction and level, open up the potential for diverse descriptions of movement to be created via the selection of associated menu items in the interface.

A FRAMEWORK FOR INTERACTIVITY

The method of mapping movement to system objects and actions, described, can be used in a number of ways to support the design of movement-centered interaction. For example, it can be used to assist the design of full body gestural interaction as opposed to those requiring the use of a mouse or pen and others that focus on hand or finger gestures with hand held devices. Corporal interactions can be designed for detection by sensor-based systems where the resulting outcomes of interaction are visually illustrated through graphical user interfaces as system objects and actions. In the following, I provide a working example (illustrated in Table 2) of how the framework can be used. For the purposes of this example, the goal of interaction between a system and end-user is to advance the slides of a PowerPoint presentation through the use of corporal gestures. It is important to emphasise that the proposed framework takes movement as the starting point for the design of interrelated experiences between humans and interactive systems. Movement constructs are also utilised for their ability to shape human actions and facilitate the design process of communicating the relationships between human movements, interactive systems and their associated objects and operations.

ELEMENTS OF MOVEMENT

To begin designing an integrated experience for the above-mentioned scenario it is necessary to describe the elements of human movement that provide a starting point for communication to take place. Identifying 'what' it is that we would like to move can be achieved by drawing on the noun movement constructs illustrated in Table 1. The 'what' element of movement can refer to either a performer's body parts or the involvement of their body parts (highlighted in grey) in combination with different body areas, areas & surfaces, locations, parts of the room, a partner or physical props. In this example, the 'involvement of body part(s)' will be the, 'what' or 'noun' rather than 'a performer's of body part(s)'. Firstly, this is done to identify the general parts of the body involved in the interaction between an individual and interactive system that aligns with the context of the situation. Making the distinction between these two key elements allows for the identification of either broad or specific elements of human movement that will shape the manner of communication. In this way designers can specify if an interactive system will be aware of a full range of corporal movement and may continue to design movement in greater detail by drawing on the noun movement constructs that are positioned below the

Human Movement		Product / Service	
Elements of Movement	**Elements of Interaction**	**System Interactivity**	**System Intent**
Noun What is moving? *Involvement of body part(s):* full body. *Location:* a three-meter space around the presentation's visual display.	**Focus** What enables interaction? *A performer's body part(s):* right shoulder, arm, hand & fingers with; *Areas & surfaces:* the palm. *Props, objects*: an interactive screen.	**Object** The object of interactivity. *Interface:* a PowerPoint slide. *Highlight:* A faint blue hue will appear around the selected interface item.	**Task** The intent of interaction. Enables an end-user to advance to the next or previous slide in a PowerPoint presentation.
Verb How is it moving? *An action:* walking & pacing with; *A pause*: to address an audience. *Spatial actions:* toward & away from the presentation's visual display.	**Event** How is interaction possible? *Rotation/twist:* of the right hand, inward & outward with; *Extension:* bend & stretch of the fingers.	**Action** The outcome of interactivity. *Interface:* A PowerPoint screen slides across the interface. *Highlight & Duration:* A slide will appear darker and smaller for two seconds before it animates away.	

Table 2. The mapping of interrelated elements of interactive products or services

first two movement elements highlighted in grey. By examining the list of possibilities for the involvement of body part(s) (on the right of Table 1) a designer can illustrate that movement will entail an individual's 'full body'. For the purposes of this example the 'location' for where this movement will take place can also be specified, as a three-meter space around the visual display of the PowerPoint presentation.

To realise 'how' the elements of movement will take shape, that is how an individual's full body will interact with the proposed system, a designer can use the verb movement constructs in Table 1 to define the broad actions that will be involved in performing 'what' it is that is moving. First of all, it can be stated that 'an action', rather than the 'absence of action' and 'stillness' (highlighted in grey), is required for a system to recognise that an individual is actively addressing an audience and a visual projection of a PowerPoint screen during a presentation. Again, these elements along with 'duration' are highlighted in grey in Table 1, as they represent important distinctions in the process of designing corporal movement that require definition before other detailed movement variations are described. Once established the direction, level, spatial actions, rotation/twist, extension, contraction, untwisted/parallel, supports, turns and jumps can be articulated. Addressing an audience as well as the visual slides of a PowerPoint presentation can be achieved by means of walking, pacing and pausing in front of a visual projection of a presentation. Here there is the possibility to include 'spatial actions' to the manner of movement such as toward, away or along a specific path that an individual could perform. Different spatial actions and patterns that an individual performs could be recognised as a cue by sensing technologies in preparation for advancing the individual screens of the presentation. A designer can therefore specify that walking, pacing and pausing to address an audience can be achieved by moving toward and away from the PowerPoint presentation's visual display. These actions will prepare the interactive system to sense specific actions (via sensor technologies) that will be used to advance the screens of the presentation and will be further defined in the elements of interaction.

ELEMENTS OF INTERACTION

After the elements of movement have been established it is important to identify the specific parts of the body that will initiate a system response and describe the elements of interaction for detection by sensor-based technologies. In doing so, this gives focus to the subsequent movement and events that will occur as a result of particular elements of interaction. Again, this can be achieved by drawing on the noun movement constructs in Table 1. This is because the elements of interaction will complement the 'what' aspect of the elements of movement. This gives focus to the specific parts of the body involved in the interaction between an individual and interactive system that aligns with the task at hand. Here, it can be said that the selection of interactive elements will be made possible though the movement of a performer's 'right shoulder, arm, hand and fingers'. These are the body parts that an individual is required to use in order to perform a movement designed to advance the screen of a PowerPoint presentation. In addition to this a detailed description of the 'areas and surfaces' of the palm and fingers of the right hand can be included. In doing so, this suggests that the palm of the right hand will become a significant element of human interaction between the system's sensors and end-user's movements. A designer can also specify that the elements of interaction be directed at specific 'props or objects'. Since the intent of interaction in this example is to communicate with the visual projection of a PowerPoint presentation, an interactive screen will be the focal element of interaction.

To envision how the manipulation of interactive elements will take shape as an event after their selection we can draw on the verb movement construct possibilities on the right of Table 1, to assist us with their conception. The manner in which an end-user will be able to advance or reverse the screens of a PowerPoint presentation can be achieved through the inward and outward motions of the hand's 'rotation/twist'. As a result the palm becomes a focal element of interaction along with the bending and stretching 'extension' of the fingers. For greater precision we could define the 'direction, level and duration' of interacting elements. However, this will be largely dependant on the technologies used to sense or register movement and are therefore not included in this example.

SYSTEM INTERACTIVITY AND PURPOSE

The description of various elements of human movement and interaction provides a basis in which to continue developing the interplay between different types of interaction that align with the intent of a product or service. The purpose of our example is to enable an end-user to advance to the next or previous slide in a PowerPoint presentation. For that reason, the associations between what enables interaction and a system of interactivity needs to be identified and interrelated to how interaction is made possible and visualised in an interface as an integrated system of communication.

For this activity it is no longer necessary to draw on the movement constructs in Table 1. Designing the objects and actions of an interactive system rests on the capacity of a designer's knowledge and experience to envision these relations. Here it is important to build relations between objects in the interface for selection, which will need to be visually highlighted to the end-user with the resulting actions that will respond to the corporal manipulation of objects over time. To assist the visual identification of a selected interface object a faint blue hue will be used to 'highlight' and give focus to selected items. As the previously defined movement event initiates the system task of changing slides in a PowerPoint presentation, a slide will appear darker and smaller for two seconds before it animates from view. This accounts for the visual 'highlight and duration' of the system's response.

By mapping out the working example as shown in Table 2 a description of human movement that aligns to a system of interactivity and its interface, is created. To extend upon this example the technical requirements for the sensor detection could also be positioned between the elements of interaction and the system interactivity in Table 2.

One could quite rightly argue that while there is a need to design the relationships between human movement and a product it is not necessary to design the relations between system objects and actions, since they can be implemented independently from human movement. However, when products that cater to a broader sense of interaction are designed holistically, it is important to consider the relation of these elements between part-to-part, part-to-whole, and whole-to-part. This is because understanding the dynamic relationships between these elements is significant to the creation of form as an organised integrated whole. Ideally, the resulting user experience, if a product and all its possible relationships are successfully aligned, should allow for a unified form of communication between the end-user, product or service and system interactivity.

I argue that through a method of mapping movement to system objects and actions, designers have the potential to develop ideas about physical movements in relation to system interactions that can be expressed with a range of movement constructs for use by emerging technologies. Rather than the categorical representation of particular objects or things, the significance of movement constructs enables different perspectives and understandings to be developed from the recognition of similarities and differences surrounding a key term. This is where the term 'body part' can broadly refer to the notion of footstep, or any other body part for that matter, which can be further defined and made specific by the inclusion of the terms 'leg,' 'forward,' and 'low'. These rather ordinary terms share similarities across all movement descriptions, and offer a place to refine broad concepts of movement. The theme in this example is relevant to the descriptive elements required by the language of Labanotation to create a single movement. It identifies the differences between the parts of the body, and also makes use of similarities relevant, but not necessary, to its description or physical positioning. Movement constructs, as opposed to categories, offer a starting point or place in which meanings can be negotiated. Rather than rely on the selection of a limited range of possibilities, which categories suggest, movement constructs open up alternate possibilities to develop interaction that integrates thought and action in an orderly manner.

THE EXPRESSION OF MOVEMENT QUALITIES

Until now, this research has focused on the interplay between different forms of interaction that encompass the human movement-based actions with system objects and actions. To augment the use of movement constructs in the design and description of movement, the quality of performed movement in terms of its style and duration should also be expressed.

Laban's Movement Analysis theory of effort, which is fundamentally different from the structured form of Labanotation, can be used to assist the characterisation of expressive movement. Research findings from a comparative analysis of tools designed to assist the identification and communication of behavior and emotion in the design process suggests, that the value of Labanotation lies not in the ability for designers to notate movement, as symbolic scores of movement, but in the movement-based perspective it brings to enhance the understanding of how interactive products could be designed (Rodríguez Ramírez, 2006). With this in mind, effort theory could be useful to the design and description of movement by giving focus to the intent, meaning, attitude, energy, feeling, tone and texture of movement (Bishko, 2005).

To summarise, effort theory is distinguished by four different qualities that can be studied in isolation or relation to one other. The qualities encompass varying degrees of 1) space: direct and indirect, 2) weight: strong and light, 3) time: sudden and sustained, and, 4) flow: bound and free. These qualities point to:

- 'Where' referring to an overall awareness of the surrounding environment,
- 'What' the sensation of physical mass and its relationship to gravity, rather than the type of weight that is measured objectively,
- 'When' an individual attitude or intuition we have about time, and
- 'How' the constant progression and expression of movement, which is embodied within, and spans across all of the effort elements of movement elements.

Yet, this is achieved in an essentially different manner to the 'what' and 'how' used in the approach to map movement to interactive systems. This is an important distinction to make because Laban's effort theory, offers designers a relevant conceptual basis from which to characterise and express different types of movement qualities in the design of movement-based interactions.

ILLUSTRATED EXAMPLE

In the following I provide an example that illustrates the overall value of the proposed framework. This includes the method of mapping movement to system objects and actions in combination with the expression of movement and product qualities. The system purpose is not included in this schematic, as shown in Table 2; however, designers may find it a useful addition. I draw on Saffer's (2008 p. 86) 'shake to change' pattern for free-from interactive gestures to demonstrate how the design of movement-based interactions can extend to include other devices or products.

In this example, a focus on human movement gives context and shape to the design of quality interactions between humans, interactive systems and products. The presentation of interaction in Table 3 works to establish a rapport among various task based objects and actions. In particular, the descriptions of human actions give greater focus to the beginning, duration and end of different system interactions. As the shake example suggests, the design of movement-based system interactions can extend to include the product as an object in which physical actions such as vibrate or any other, can be associated as a result of an individual's actions. The manner in which movement-based interactions can be successfully implemented into existing or emerging uses of technology will, however, require further negotiation and development in partnership with skilled computer engineers.

DISCUSSION

This paper focuses on the way in which various elements of the language of Labanotation can assist the creation and description of movement-based interaction that enables communication between humans, computer systems and in certain circumstances other devices or objects to be shaped as organised integrated experiences. A process of mapping movement that draws on the underlying structure of Labanotation in conjunction with the theory and descriptive attributes of LMA provides researchers with an analytical framework in which to understand and document movement qualities using a common vocabulary.

Outcomes of this research have the potential to

Pattern	Elements of Movement	Elements of Interaction	System Interactivity	Product
Shake	**Noun** *Involvement of body part(s):* shoulder, arm, wrist, hand and fingers with; *Areas & surfaces:* the palm. *Props, objects:* a mobile device.	**Focus** *Body part(s)*: Hand, wrist, forearm & upper arm. *Direction:* Left side, right side forward or backward. *Level:* Middle.	**Object** *Interface*: Screen content	**Item** *Entity:* Entirety
	Verb *An action:* Interacting with an object. *Supports*: Holding a device.	**Event** *Body part(s)*: Begin by shaking back & forth or side to side. End when shaking ceases. *Duration:* 1 second.	**Action** *Interface:* Begin by displaying current content. End with new content. *Highlight:* Display a content update icon. *Duration:* Each movement refreshes the content displayed.	**Quality** *Interaction:* Vibrate playfully (rather than urgently)
		Effort *Space:* Direct *Weight:* Strong *Time:* Sudden *Flow:* Bound		

Table 3. Shake to change with the expression of movement and product qualities.

enhance the design and documentation of human movement-centered interaction. The proposed framework offers designers a comprehensive tool set to develop ideas about physical movement in relation to system objects and operations. An idea is understood as the organising principle behind the choice and development of interactivity required for the description and design of movement-centered interaction. Therefore, new movements and their qualities can be expressed in different forms with a range of movement constructs. The manner in which movement is described becomes a way for human action that complements interface objects and actions to be designed. As a result, a symbolic understanding of the language of Labanotation is not required in the design of movement-based interactions for emerging technologies.

It is envisaged that that the proposed framework for designing movement-based interactions will be further tested amongst members of the design community in application to research on interactive objects, service systems, and physical computing. This will be done to better understand the potential value of Labanotation to the field of design and the role of movement constructs as a way to facilitate the design of new forms of interactive movements. Fruitful directions for this research include examining the way in which movement-based interactions can be designed, not only to address well-established object-action interface paradigms, but also new forms of communication in which human movement will play a greater role when the focal point of interaction is no longer visual.

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