

Tutorial on Movement Notation: An Interdisciplinary Methodology for HRI to Reveal the Bodily Expression of Human Counterparts via Collecting Annotations from Dancers in a Shared Data Repository

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Figure 1: Similar tutorials in movement studies and notation. Images by Catie Cuan (left) and Amy LaViers (right).

ABSTRACT

How do we make a machine that indicates changes to its internal state, e.g., status, goals, attitude, or even emotion, through changes in movement profiles? This workshop will pose a possible direction toward such ends that leverages movement notation as a source for clearly defining abstract concepts of similarity and symbolic representation of the parts and patterns of movement - in order to identify, record and interpret patterns of human movement on both the micro and macro levels. First, we will move together. This will activate an innate ability to imitate each other and, in doing so, illuminate the principal components of Laban/Bartenieff Movement Studies – a field comprised of Laban Movement Analysis and Bartenieff Fundamentals – and the Body, Effort, Shape, Space, and Time (BESST) System of movement analysis. This system of work, deriving from dance and physical therapy practices, which is

often leveraged in HRI research, is difficult to absorb solely from a textbook; thus, a key value proposition of the workshop is in its embodied, situated nature that can be supplemented by textbooks, including a newly released book from MIT Press authored by the workshop organizers. Next, we will try to write down what we're doing. A set of symbols for describing elements of the BESST System, which seem to be particularly perceptually meaningful to human observers, will be presented so that movement ideas can be notated and, thus, translated between bodies. We will explore both Labanotation and a related “motif”-style notation. This workshop is supported by NSF grant numbers 2234195 and 2234197.

CCS CONCEPTS

• Applied computing → Performing arts; • Human-centered computing;

KEYWORDS

Expressive robotics, Social HRI, Movement analysis, Laban Movement Analysis (LMA), Movement notation, Labanotation

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1 INTRODUCTION

Machines designed for functional objectives without considering expressive intent can create disharmony. A salient real world example comes from embodied agents moving on factory floors, e.g., Amazon and FedEx, that contain few visual signifiers of their internal state (Are they almost at their destination and stopping soon? Are they about to turn left? Do they see that you're about to cross their path?— questions which are often answered in humans by subtle postural shifts and changes in gait). Without visual clues [1], workers go out of their way to take long pathways around these machines [3].

An area of special interest in HRI is in understanding the emotions of human counterparts [2]. Often, human bodily movement expresses internal emotion through changes in bodily action [7]. Using large datasets that combine expert and lay human annotation is one approach to developing models for and incorporating such information [6, 8].

Engineers can benefit from training in or mindfulness of their own movement experience and the movement of those around them, noting the role of context and environment in generating this movement, in order to support their design work and enhancing the capacity for meaningful interactive design [4]. This workshop will provide participants a path to harmonious design of machine movement, offering an understanding of the role of context, content and application of movement in a broader whole – to support the creation of meaningful human/technology interactions.

This workshop is supported by the National Science Foundation (NSF) through a CISE infrastructure grant that is funding the creation of a large database of annotated bodily movement that will use the notation system taught in this tutorial (as well as other label styles, e.g., emotion) to the end of becoming a shared resource and repository for rich examples of human movement that can aid the development of robotics and AI. The workshop will serve as training grounds for those interested in using the database as well as a point of feedback for development.

2 OVERVIEW

The day will open with an embodied movement class relaying several selected topics in movement studies: the duality between function and expression, components of descriptive terminology for movement, and notation. This tutorial will get people moving and include activities specifically aimed at introductions between attendees. The experience will be led by Cat Maguire, a senior teacher and affiliated faculty at the Laban/Bartenieff Institute of Movement Studies, and Amy LaViers, a researcher who has worked at the intersection of robotics and dance for over a decade. The material for the tutorial is informed by the forthcoming book from MIT Press *Making Meaning with Machines: Somatic Strategies, Choreographic Technologies, and Notational Abstractions Through a Laban/Bartenieff Lens* that was released on October 10, 2023 [5].

This tutorial will be supplemented by an invited conversation between Monica Thomas and the workshop organizers, analyzing her experience in choreographing with various Boston Dynamics robot platforms.

Finally, workshop attendees will be offered structured (a finishing debrief with breakout groups) and unstructured (dinner) opportunity to mingle and discuss the insights from the day further. The workshop organizers will encourage a friendly and supportive atmosphere all day, with an eye toward making these ending events successful at facilitating learning, networking, and brainstorming – as well as fun. Similarly, the breaks sprinkled throughout the day will be taken very seriously in order to create time for sustenance, sidebars, and small talk.

Learning objectives for the workshop are:

- Reviewing historical development and introducing mechanics of movement notation, specifically, a form of motif related to Labanotation
- Practicing methodology for observing bodily (human and robot) movement and applying annotations rooted in a formal system of movement notation
- Recognizing the role of context, bias, and human preference in creating the annotations
- Identifying essence of a movement phrase and recognizing similar “expressions” on different bodies, in different contexts, and/or in distinct movement phrases
- Embodying different movement phrases with expressive clarity Understanding the potential for this methodology in HRI (or other human-machine interaction scenarios)
- Giving feedback based on own research to the developers of shared infrastructure that will enable HRI researchers to use annotated human movement in their development processes

A schedule is provided in Fig. 2. Zoom participants will be monitored by instructors (one will lead the content while the other monitors, switching off for different sessions) and included in the tutorial via projection onto presenter screen during the interactive movement portions of the day.

3 AUDIENCE

Graduate students, technical researchers, and product designers who are working in areas of human-robot, human-computer, and human-machine interaction and need better background knowledge of fundamental ideas about choreography of human bodies (either for interaction with or imitation thereof) will find the system of movement analysis taught in this workshop to be a great resource.

4 SPEAKER BIO

Monica Thomas is an interdisciplinary artist working in movement and video: a director and choreographer. Her dance for camera work has shown in festivals nationally and internationally, recently at Dance Camera West, Barcelona Independent Film Festival, Aesthetica Short Film Festival, Brooklyn Film Festival, and American Dance Festival's Movies by Movers. In 2017 she presented a site-specific live performance and created a dance for camera series as a Performance Lab artist at Crystal Bridges Museum of American

Time	Activity	Comments
8:30 – 9:00	Names, Introductions, and BESST System Overview	
9:00 – 9:50	Conversation with Monica Thomas	<i>Livestream</i>
10:00 – 10:50	Observation and Kinesthetic Attunement	
11:00 – 11:50	Notating with Action Stroke, Indicating Relative Duration, Emphasis, and Phrasing	<i>Livestream</i>
12:00 – 12:45	Replacing Action Strokes with BESST Symbols and Embodying Choreography from Notation	<i>Livestream</i>
12:45 – 1:00	Ending Remarks	
1:00 – 2:00	Debrief (over lunch)	<i>Optional</i>

Figure 2: Schedule for tutorial.

Art. Additionally, Monica was the choreographer for Boston Dynamic’s “Do You Love Me” dance video on YouTube (currently up to 39 million plus views) featuring Atlas, Spot and Handle.

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REFERENCES

- [1] Alexandra Bacula, Jason Mercer, and Heather Knight. 2020. Legible light communications for factory robots. In *Companion of the 2020 ACM/IEEE International Conference on Human-Robot Interaction*. 119–121.
- [2] Cynthia Breazeal. 2004. Function meets style: insights from emotion theory applied to HRI. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)* 34, 2 (2004), 187–194.
- [3] Alessandro Delfanti. 2021. *The warehouse. Workers and robots at Amazon*. Pluto Books.
- [4] Amy LaViers, Catie Cuan, Catherine Maguire, Karen Bradley, Kim Brooks Mata, Alexandra Nilles, Ilya Vidrin, Novoneel Chakraborty, Madison Heimerdinger, Umer Huzaifa, et al. 2018. Choreographic and somatic approaches for the development of expressive robotic systems. In *Arts*, Vol. 7. MDPI, 11.
- [5] Amy LaViers and Catherine Maguire. 2023. *Making Meaning with Machines: Somatic Strategies, Choreographic Technologies, and Notational Abstractions Through a Laban/Bartenieff Lens*. MIT Press.
- [6] Yu Luo, Jianbo Ye, Reginald B Adams, Jia Li, Michelle G Newman, and James Z Wang. 2020. ARBEE: Towards automated recognition of bodily expression of emotion in the wild. *International journal of computer vision* 128 (2020), 1–25.
- [7] Ayelet Melzer, Tal Shafir, and Rachele Palnick Tsachor. 2019. How do we recognize emotion from movement? Specific motor components contribute to the recognition of each emotion. *Frontiers in psychology* (2019), 1389.
- [8] Chenyan Wu, Dolzodmaa Davaasuren, Tal Shafir, Rachele Tsachor, and James Z Wang. 2023. Bodily expressed emotion understanding through integrating Laban movement analysis. *Patterns* (2023), 1–14. <https://doi.org/10.1016/j.patter.2023.100816>